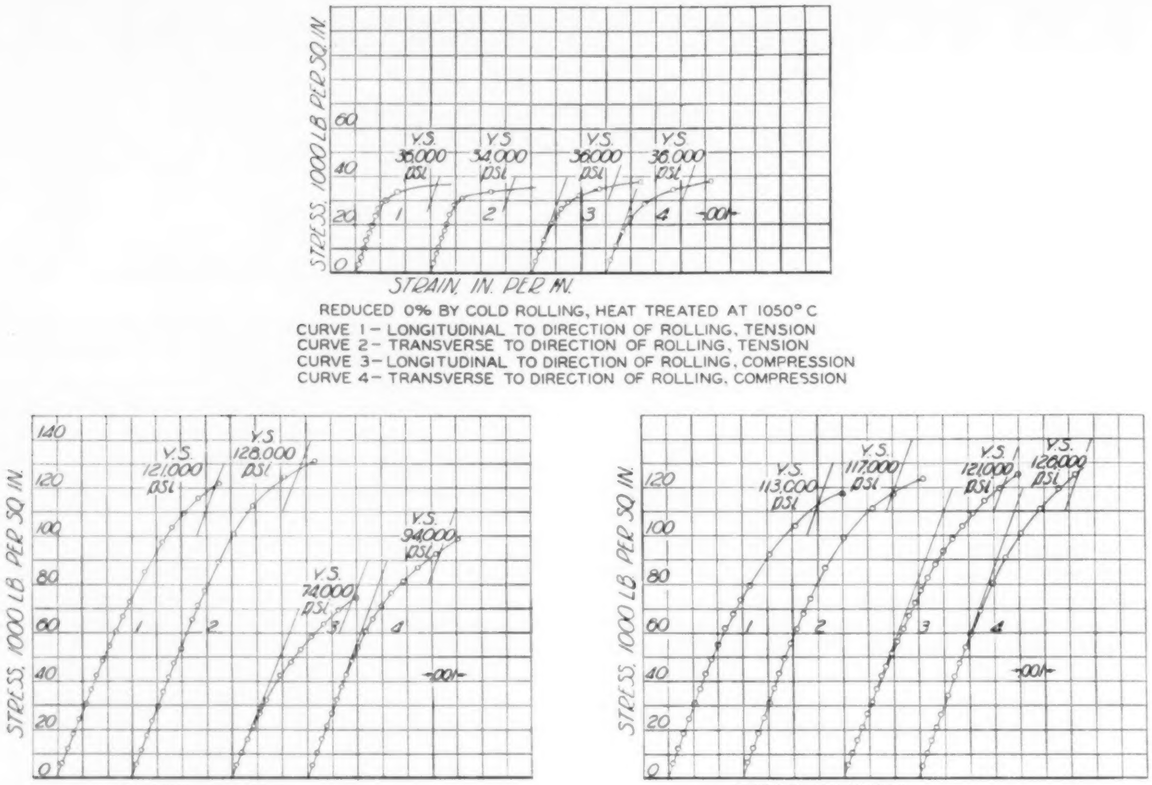

FIG. 1 STRESS-STRAIN CURVES FOR 18 PER CENT CHROMIUM, 8 PER CENT NICKEL STEEL

strength at 0.2 per cent offset,[2] but they were removed before the sample failed.

Data on the 18-8 steel are given in Table 1 and in Figs. 1 and 2. The data in Table 1 illustrate the properties of the 18-8 steel strip in the annealed, quarter-hard, and half-hard conditions. Fig. 1 illustrates the typical stress-strain characteristics of the steel under the same conditions, while Fig. 2 gives the tangent modulus curves constructed from the compressive stress-strain data. The data show that the cold-rolled 18-8 steel has satisfactory ductility with a tensile strength up to about 150,000 psi, but the yield strength at 0.2 per cent offset is lower in compression than in tension in the direction longitudinal to rolling. Conversely, in the transverse direction the yield strength is higher in compression than in tension. The tangent modulus curves of Fig. 2 show the marked effect of the low-temperature

[2] U. S. Navy Department Specification No. 47S21.

TABLE 1 DATA FOR 0.035-IN-THICK STRIP OF AN 18-8 STEEL CONTAINING 18.45% CR, 8.79% NI, 0.50% MN, 0.55% SI, AND 0.10% C

			Tension						Compression			
Per cent cold reduction	Condition of metal	Direction to rolling	Initial tangent *E* in million psi	Proportional limit, psi	Yield strength 0.2 per cent offset, psi	Tensile strength, psi	Elongation, per cent in 2 in.	Rockwell hardness	Initial tangent *E* in million psi	Proportional limit, psi	Yield strength 0.2 per cent offset, psi	Buckling stress, psi
...	*A*	*L*	29	13,300	36,000	94,500	61	80B	28	11,000	36,000	50,250
..	*A*	*T*	29	16,600	34,000	93,700	61	...	28	11,000	36,000	50,000
20	1	*L*	27	21,000	121,000	139,300	22	29C	26	23,700	74,000	120,400
20	2	*L*	27	50,000	128,000	141,200	20	30C	28	42,000	94,000	129,400
20	1	*T*	28	40,000	113,000	138,500	17	...	27	36,900	121,000	145,000
20	2	*T*	29	55,000	117,000	141,800	14	...	28	54,000	126,000	147,500
35	1	*L*	26	53,000	131,000	155,300	15	36C	26	17,100	95,000	151,800
35	2	*L*	27	60,000	155,000	173,400	11	37C	27	47,600	118,000	158,000
35	1	*T*	30	56,000	130,000	166,200	11	...	27	42,700	149,000	183,110
35	2	*T*	31	56,000	147,000	178,700	10	...	29	72,000	169,000	193,000

A = Annealed.
1 = As cold-rolled.
2 = Cold-rolled, heated 72 hr at 200 C and air-cooled.
L = Longitudinal to direction of rolling.
T = Transverse to direction of rolling.

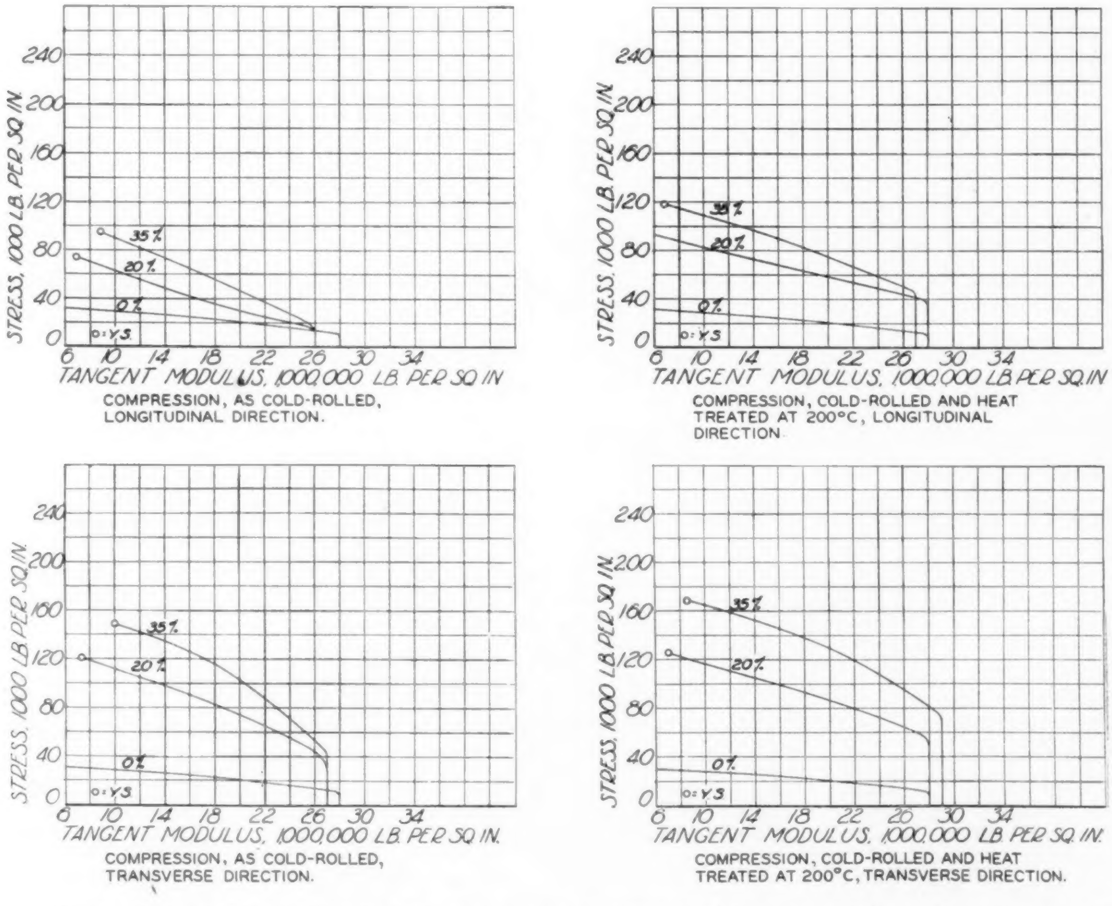

FIG. 2 TANGENT MODULUS CURVES DERIVED FROM STRESS-STRAIN CURVES FOR 18 PER CENT CHROMIUM, 8 PER CENT NICKEL STEEL

heat-treatment at 200 C (392 F) in improving the compressive stress-strain properties.

It is shown in Table 2 and Figs. 3 and 4 that cold-rolling is far more effective in increasing the strength of the 17-7 steel than of the 18-8 steel. With substantially the same percentages of cold reduction the 17-7 steel develops higher strength in both tension and compression with at least equal ductility. The tension and compressive yield strengths of the 17-7 steel in the longitudinal direction are closer together than those of the 18-8 steel, particularly after the stress-relieving heat-treatment at 200–300 C (392–570 F). There is a difference between the tensile and compressive yield strengths in the directions longitudinal and transverse to rolling, and as before, the yield strength in compression is higher in the transverse direction than it is in tension. Thus, it is observed that with the 17-7 steel high strength and good ductility are obtainable, which means that this steel is to be preferred when forming is required in building high-strength structures. These data for the 17-7

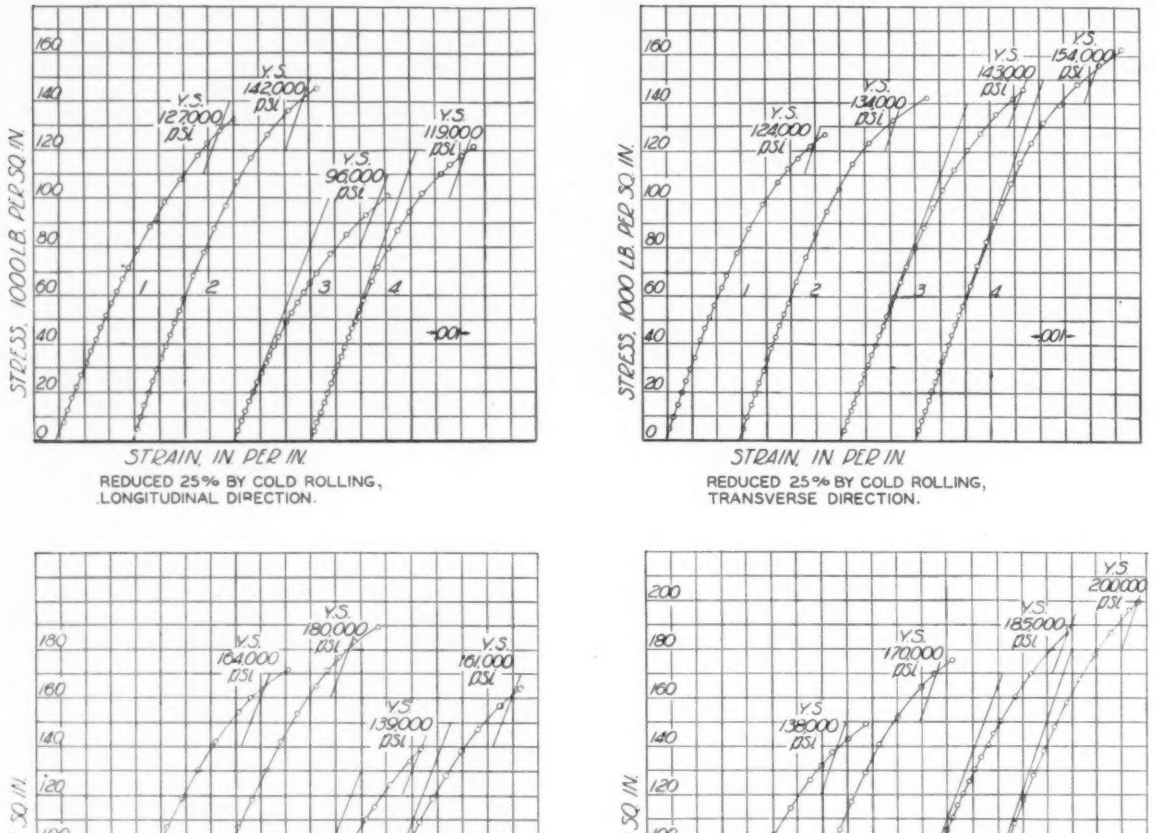

FIG. 3 STRESS-STRAIN CURVES FOR 17 PER CENT CHROMIUM, 7 PER CENT NICKEL STEEL

TABLE 2 DATA FOR 0.035-IN-THICK STRIP OF A 17-7 STEEL CONTAINING 17.33% CR, 7.14% NI, 1.29% MN, 0.37% SI, AND 0.13% C

			Tension						Compression			
Per cent cold reduction	Condition of metal	Direction to rolling	Initial tangent *E* in million psi	Proportional limit, psi	Yield strength 0.2 per cent offset, psi	Tensile strength, psi	Elongation, per cent in 2 in.	Rockwell hardness	Initial tangent *E* in million psi	Proportional limit, psi	Yield strength 0.2 per cent offset, psi	Buckling stress, psi
..	*A*	*L*	29	14,000	33,000	117,800	68	85B	28	12,000	40,000	57,800
..	*A*	*T*	29	15,700	33,000	113,500	62	...	29	12,000	44,000	57,400
25	1	*L*	28	22,000	127,000	165,200	24	38C	26	16,000	96,000	151,400
25	3	*L*	29	36,000	142,000	167,000	23	39C	28	48,000	119,000	156,100
25	1	*T*	30	45,000	124,000	170,500	17	...	28	43,000	143,000	172,200
25	3	*T*	30	60,000	134,000	167,200	18	...	29	54,000	154,000	177,500
35	1	*L*	26	50,000	164,000	196,000	15	43C	26	29,700	139,000	184,500
35	2	*L*	27	53,000	180,000	198,000	14	44C	27	62,000	161,000	201,200
35	1	*T*	30	46,400	138,000	201,000	10	...	27	47,000	185,000	214,300
35	2	*T*	30	61,000	170,000	202,000	10	...	29	65,000	200,000	218,500

A = Annealed.
1 = As cold-rolled.
2 = Cold-rolled, heated 72 hr at 200 C and air-cooled.
3 = Cold-rolled, heated 24 hr at 275 C and air-cooled.
L = Longitudinal to direction of rolling.
T = Transverse to direction of rolling.

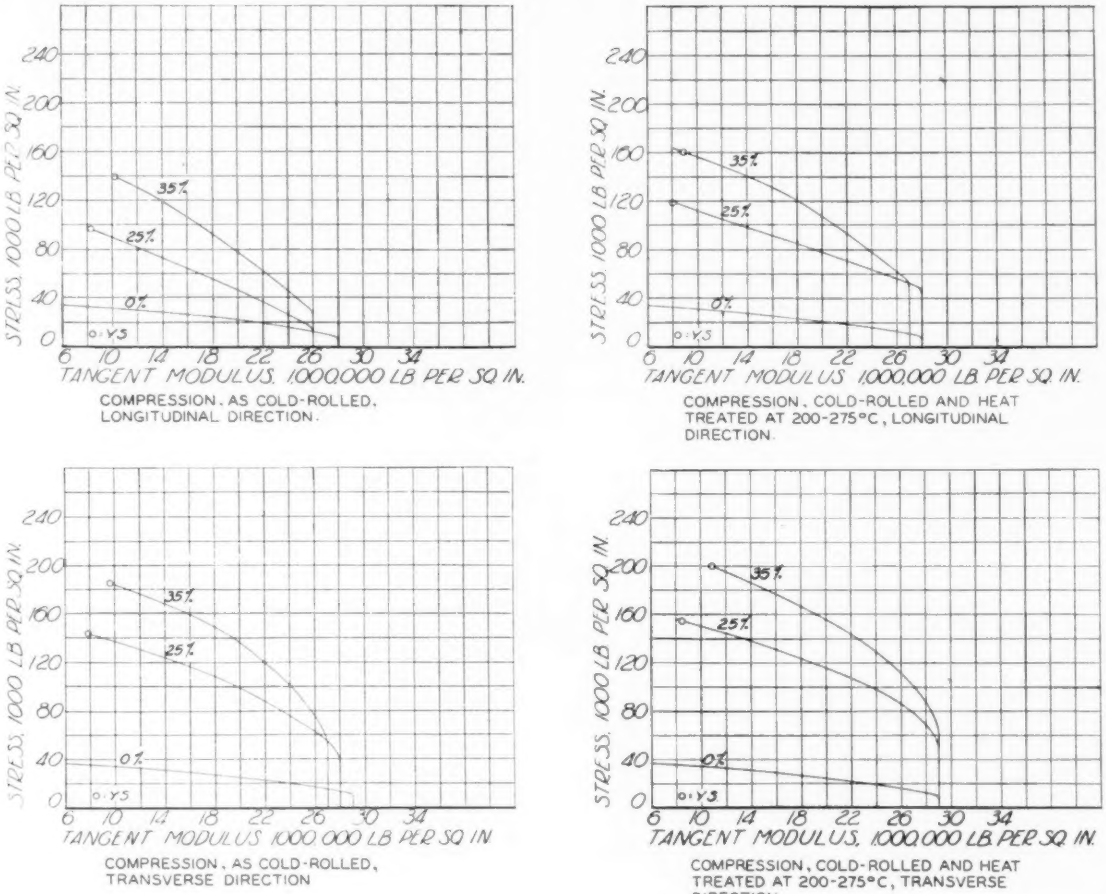

FIG. 4 TANGENT MODULUS CURVES DERIVED FROM STRESS-STRAIN CURVES FOR 17 PER CENT CHROMIUM, 7 PER CENT NICKEL STEEL

steel are typical for the half-hard and full-hard conditions.

In Table 3, and Figs. 5 and 6, data are given for the 17-5-4 steel. It should be noted that the tensile strength of this steel is rapidly increased by cold-rolling, and that after the low-temperature stress-relieving treatment the strip has almost the same yield strength in tension as in compression in the direction longitudinal to rolling. The steel has high ductility which is retained after stress-relieving. As in the case of the 17-7 steel the 17-5-4 steel has superior physical properties to the cold-rolled 18-8 steel, and the steel is at least equal in physical properties to the 17-7 steel. The indications are that the chromium-manganese-nickel steel has somewhat higher ductility for a given strength than the 17-7 steel, and as in the two previous instances, the 17-5-4 steel has different properties in the longitudinal and transverse directions, which should be considered in using it for structural members.

APPLICATION OF COLD-ROLLED STAINLESS STEEL TO AIRCRAFT

Many references have been made to the use of cold-rolled stainless steels in lightweight high-strength structures. Based upon experience, Ragsdale (9), Ffield (10), deGanahl (11, 12, 13), Sutton (14, 15), and Thaden (16) have pointed out the advantages to be gained in using cold-rolled stainless steels for lightweight structures. Ragsdale emphasizes the ease with which the cold-rolled stainless steels can be joined by the spot-welding process. Ffield states that although the straight 13 per cent chromium steel has better mechanical properties than the cold-rolled 18-8 steel, the latter steel is to be preferred on account of its superior welding characteristics. It has been claimed that the cold-rolled stainless steels have a relatively low initial modulus but neither the data of this paper nor those of Sutton and Thaden agree with this claim. Thaden observed that in the elastic range, stainless steel, like ordinary carbon steel, has a modulus of 28,000,000 to 29,000,000 psi and that this holds not only for the annealed but for the cold-rolled steel. Sutton discusses the elastic characteristics and states that while the cold-rolled 18-8 steel offers no advantage for long columns it is especially suitable for short-column construction. DeGanahl's work with cold-rolled stainless steel has verified the suitability of the material for aircraft structures, and he has supplied the photographs discussed herein to illustrate some of the structures built by Fleetwings, Inc.

The photographs of Fig. 7 illustrate the appearance of a plane built by Fleetwings, Inc., for Army basic training purposes. The photographs do not show clearly the spot-welding method of joining but it can be said that the plane has been built almost entirely using this procedure. The main structural members of the plane are made of cold-rolled stainless steels of the 18-8 and 17-7 types, and have a thin covering of cold-rolled stainless steel on the outside spot-welded to an inside corrugated covering to gain stiffness, which will become evident in the discussion of the photographs showing more detail. The photographs show how the cold-rolled stainless-steel strip can be formed and fabricated into outer skin for the planes, which leaves the surfaces smooth so that wind resistance is at a minimum.

Fig. 8 gives detailed views of the root section of the outer wing panel and of the outboard end of the center section of the wing, which illustrate typical construction used in fabricating an all-stainless-steel wing. The two photographs in this figure

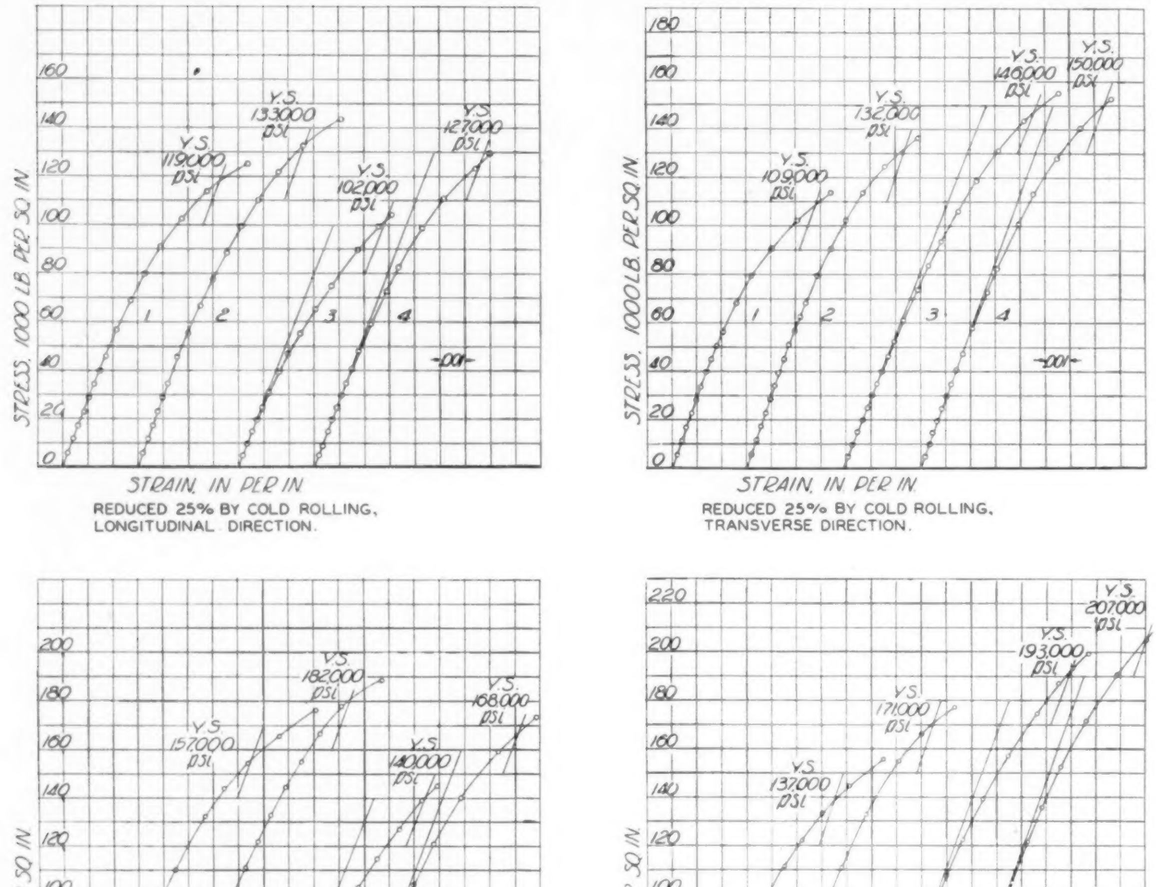

FIG. 5 STRESS-STRAIN CURVES FOR STEEL CONTAINING 17.52 PER CENT CHROMIUM, 4.34 PER CENT NICKEL, 5.43 PER CENT MANGANESE, 0.27 PER CENT SILICON, AND 0.12 PER CENT CARBON

TABLE 3 DATA FOR 0.035-IN-THICK STRIP OF A 17-5-4 STEEL CONTAINING 17.52% CR, 5.43% MN, 4.34% NI, 0.27% SI, AND 0.12% C

			Tension						Compression			
Per cent cold reduction	Condition of metal	Direction to rolling	Initial tangent *E* in million psi	Proportional limit, psi	Yield strength, 0.2 per cent offset, psi	Tensile strength, psi	Elongation, per cent in 2 in.	Rockwell hardness	Initial tangent *E* in million psi	Proportional limit, psi	Yield strength, 0.2 per cent offset, psi	Buckling stress, psi
..	*A*	*L*	29	25,500	40,700	138,500	65	90B	29	15,000	48,000	70,200
..	*A*	*T*	29	25,500	41,000	141,500	62	...	29	10,000	48,000	70,300
25	1	*L*	27	34,100	119,000	183,000	25	40C	26	18,300	102,000	160,000
25	2	*L*	28	34,100	133,000	179,500	32	40C	27	38,200	127,000	165,000
25	1	*T*	29	44,000	109,000	199,500	14	...	26	39,900	146,000	174,700
25	2	*T*	29	45,000	132,000	173,500	17	...	28	56,000	150,000	176,000
35	1	*L*	28	33,000	157,000	213,000	19	45C	26	28,700	140,000	192,500
35	2	*L*	28	54,000	182,000	203,500	18	45C	27	57,400	168,000	202,000
35	1	*T*	31	40,000	137,000	215,000	10	...	28	48,800	193,000	218,700
35	2	*T*	31	52,000	171,000	207,000	10	...	29	95,000	207,000	228,600

A = Annealed.
1 = As cold-rolled.
2 = As cold-rolled, heated 24 hr at 225 C and air-cooled.
L = Longitudinal to the direction of rolling.
T = Transverse to the direction of rolling.

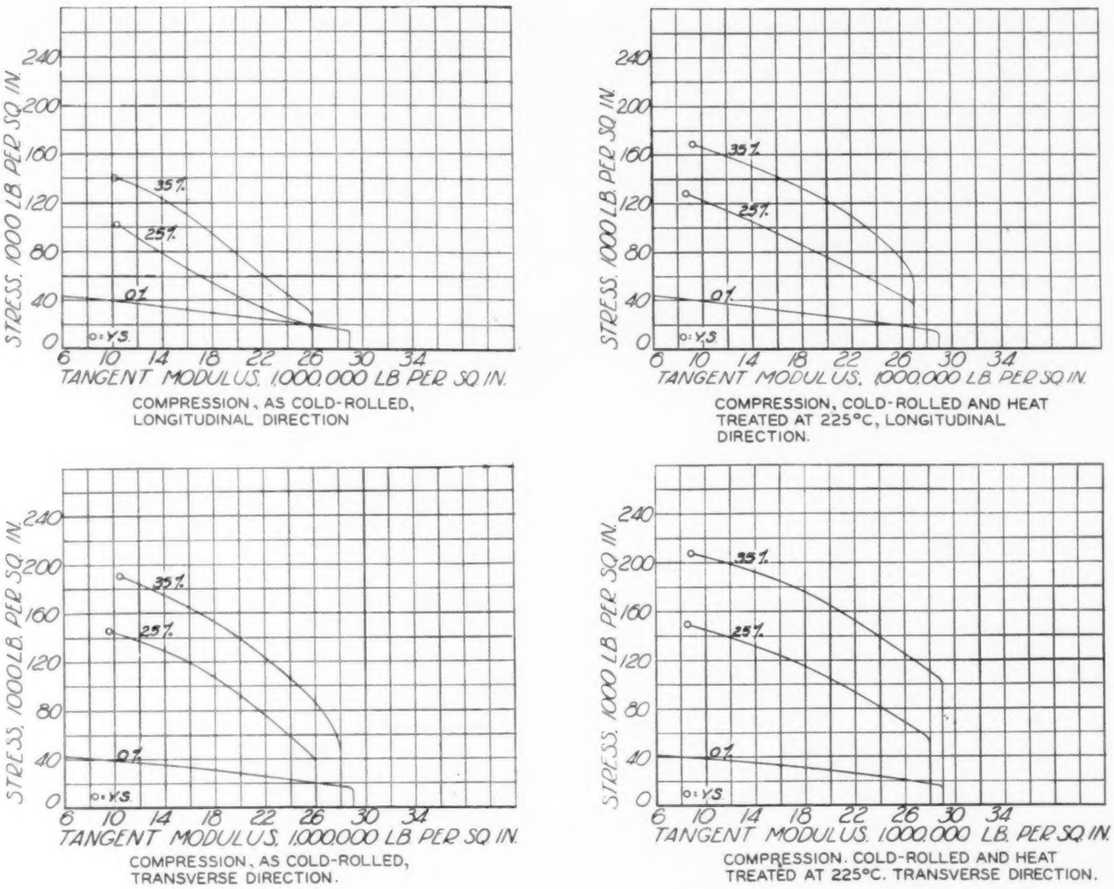

FIG. 6 TANGENT MODULUS CURVES DERIVED FROM STRESS-STRAIN CURVES FOR STEEL CONTAINING 17.52 PER CENT CHROMIUM, 4.34 PER CENT NICKEL, 5.43 PER CENT MANGANESE, 0.27 PER CENT SILICON, AND 0.12 PER CENT CARBON

show the position of the main wing spar in relation to the cross section of the wing, and the manner in which the wing is stiffened by using a corrugated sheet on the inside and a flat sheet on the outside, both of which are supported by the main spar member which is also corrugated. The relatively short columns in the wing add greatly to its stiffness without unduly increasing weight. It can be observed in the lower photograph of this figure that the gusset plates are flanged to gain stiffness. The general use of spot-welding is in evidence, although both photographs show the manner in which bolts are used to attach the outer panel to the center section of the wing.

The photographs of Fig. 9 show a top view of the wing section, an inboard flap, and the lower part of the monocoque section of the fuselage. For these sections corrugated sheets are used on the inside surface in those locations that require extra stiffness. For example, the forward portion of the wing is of corrugated-sheet construction, while the aft portion of the wing is made of truss-type ribs covered with fabric. However, the entire part of the lower monocoque contains the corrugated sheets covered on the outside with the flat stainless-steel strip. A study of these photographs shows the widespread use of spot-welding and reveals the importance of this method of joining thin stainless-steel parts in building lightweight structures.

The remaining photographs, Fig. 10, show the appearance of the stabilizer in the tail of the plane and the aft bulkhead of the lower monocoque fuselage section. The bottom part of the stabilizer, where it is attached to the fuselage of the plane, employs the corrugated section to obtain extra stiffness. The photograph of the rear lower monocoque section shows that this part of the plane is constructed of relatively heavy sections shaped in all instances to gain rigidity. The size of the spot welds is indicative of greater thickness of most of the sections in this part of the plane.

SUMMARY

This discussion of the cold-rolled austenitic stainless steels has shown that it is necessary to control the composition of the steels and the amount of cold work applied to them to preserve good ductility with high strength. Too much emphasis cannot be placed upon ductility, as this property is highly important from the standpoint of fabrication. If the composition and percentage of cold reduction are properly controlled, the steels have predictable stress-strain characteristics and are readily fabricated into lightweight high-strength structures.

When the tensile-strength requirement does not greatly exceed 150,000 psi, the 18 per cent chromium and 8 per cent nickel steel is considered satisfactory, but if higher tensile strength is needed, for example, 175,000 to 200,000 psi, the cold-rolled 17 per cent chromium and 7 per cent nickel steel is to be preferred because of its higher ductility. Similarly, high strength with somewhat greater ductility than that of the 17-7 steel is obtained with the cold-rolled 17 per cent chromium, 5 per cent manganese, 4 per cent nickel steel.

The compressive yield strength of the 18-8 steel in the direction longitudinal to rolling is not so high as the tensile yield strength, and this fact should be taken into consideration in designing structures of the steel. The compressive yield strengths of the 17-7 steel and the 17-5-4 steel are higher and more nearly approach their tensile yield strengths in the direction longitudinal to rolling. However, the compressive yield

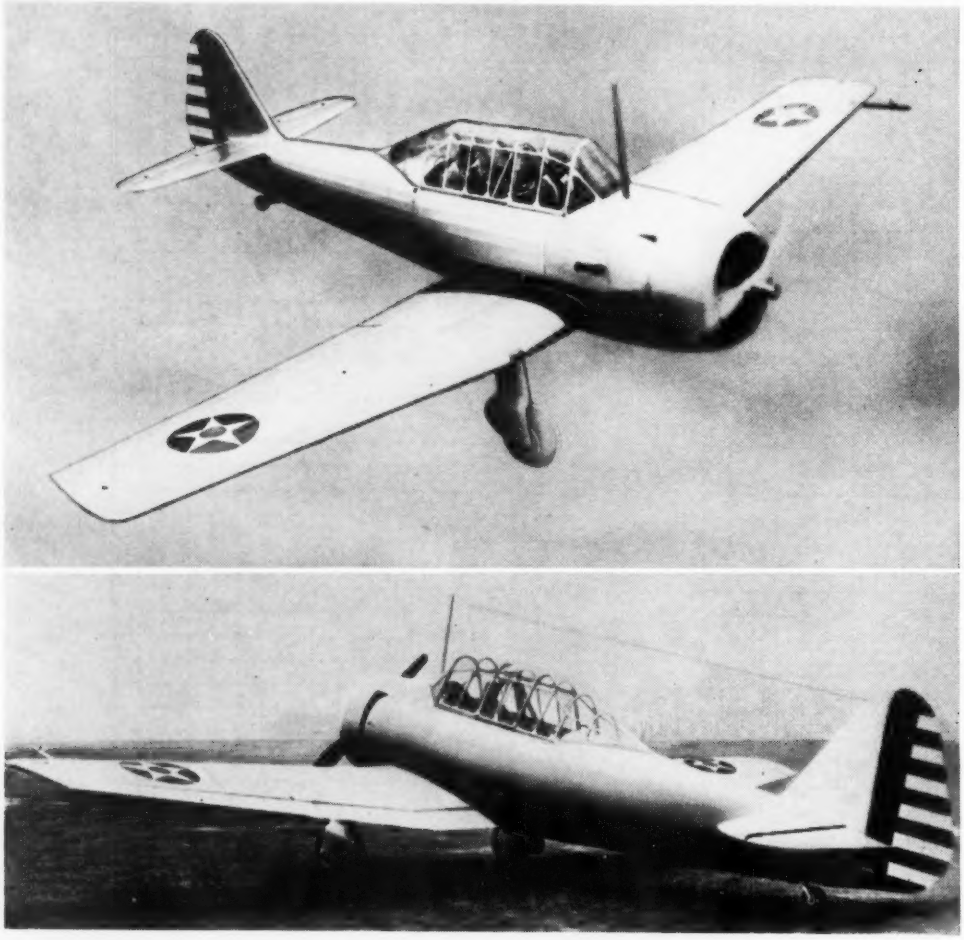

FIG. 7 TWO VIEWS OF STAINLESS-STEEL AIRPLANE (ARMY BASIC TRAINER)

FIG. 8 SECTIONS OF STAINLESS-STEEL AIRPLANE WING

(*Top:* Root section of outer wing panel. *Bottom:* Outboard end of center section of wing.)

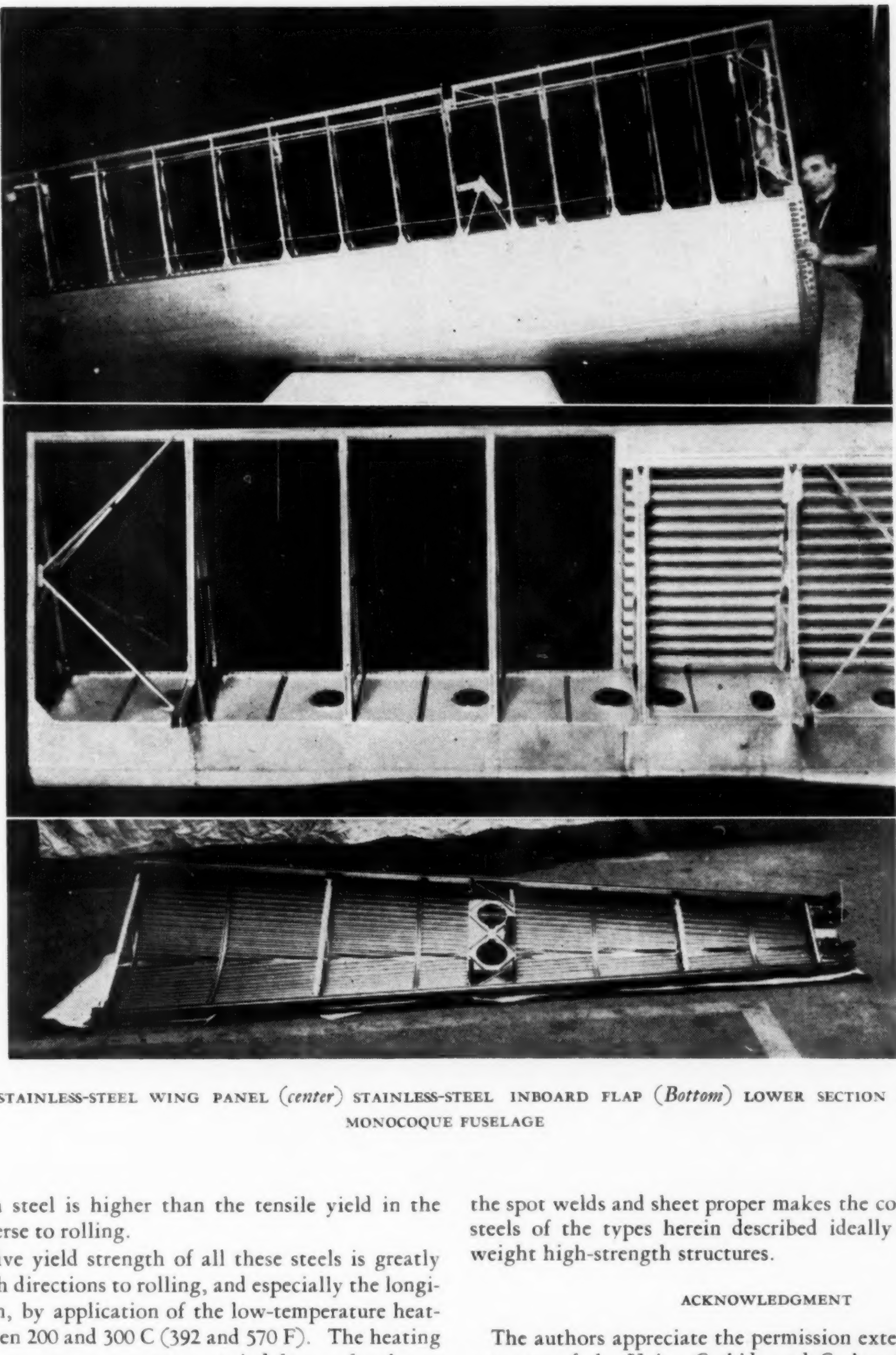

FIG. 9 (*Top*) STAINLESS-STEEL WING PANEL (*center*) STAINLESS-STEEL INBOARD FLAP (*Bottom*) LOWER SECTION STAINLESS-STEEL MONOCOQUE FUSELAGE

strength of each steel is higher than the tensile yield in the direction transverse to rolling.

The compressive yield strength of all these steels is greatly improved in both directions to rolling, and especially the longitudinal direction, by application of the low-temperature heat-treatment between 200 and 300 C (392 and 570 F). The heating in this temperature range consumes a period from a few hours up to 72 hours, although ordinarily heating for 24 hours is sufficient. After this treatment the compressive and tensile yield strengths of the 17-5-4 steel are approximately equal to each other.

A number of photographs have been presented to illustrate how the 18-8 and 17-7 steels are successfully applied in aircraft design. In studying these illustrations the excellent forming characteristics of these steels after cold-rolling to high strengths are in evidence. The pictures reveal the widespread use of spot-welding in joining the thin stainless-steel section, which in addition to the strength, ductility, and corrosion resistance of the spot welds and sheet proper makes the cold-rolled stainless steels of the types herein described ideally suited for light-weight high-strength structures.

ACKNOWLEDGMENT

The authors appreciate the permission extended by the management of the Union Carbide and Carbon Research Laboratories, Inc., to publish these data. They also appreciate the assistance of Messrs. James Thompson, Charles Brown, Lawrence De'Aeth, Andrew Wentworth, and James MacLean in the preparation and testing of the different steels. Their appreciation is cordially extended to Mr. Carl deGanahl of Fleetwings, Inc., for his kind co-operation in supplying the photographs that are included.

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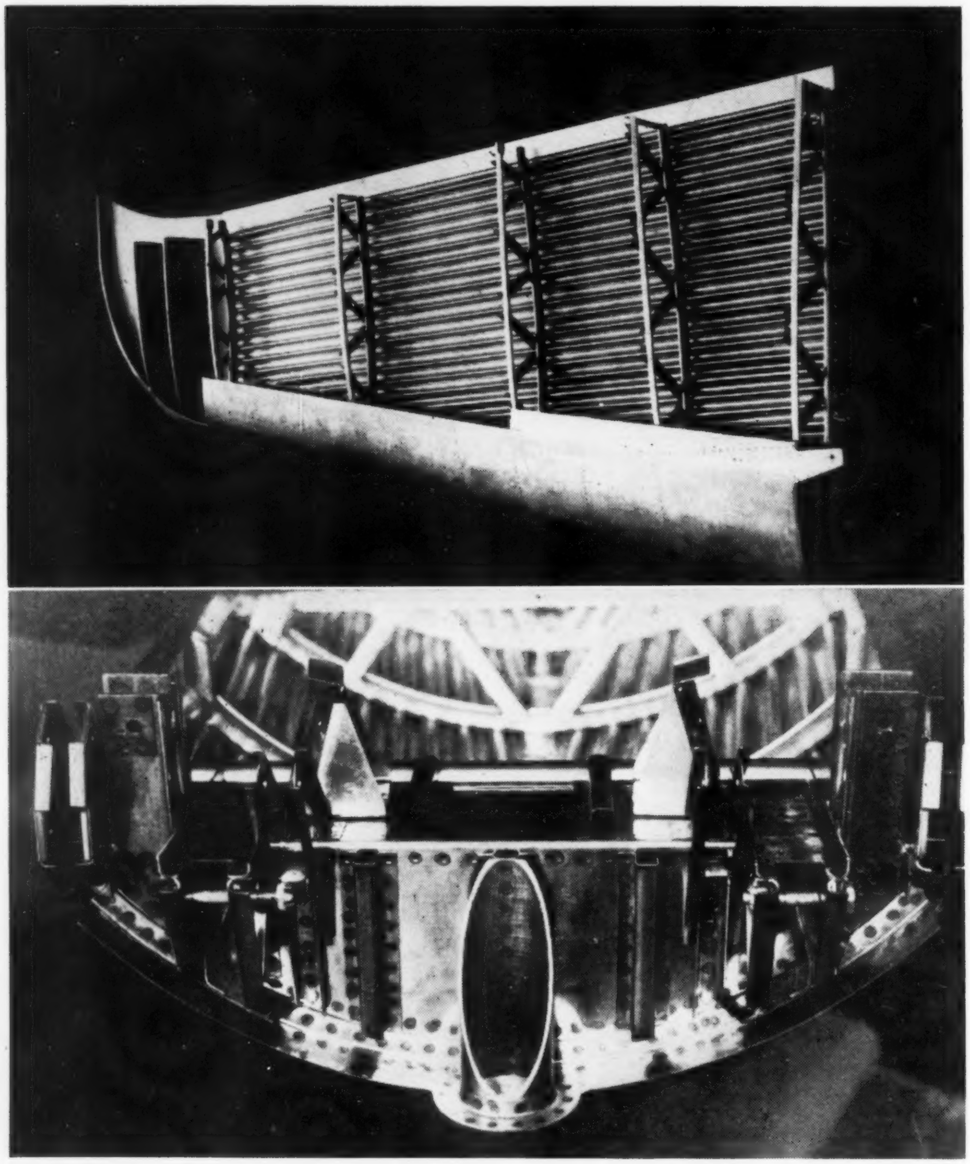

FIG. 10 (*Top*) STAINLESS-STEEL STABILIZER IN TAIL OF PLANE WITH ONE SIDE UNCOVERED (*Bottom*) REAR BULKHEAD OF LOWER MONOCOQUE FUSELAGE SECTION WHICH SUPPORTS THE TAIL CONE OF THE FUSELAGE

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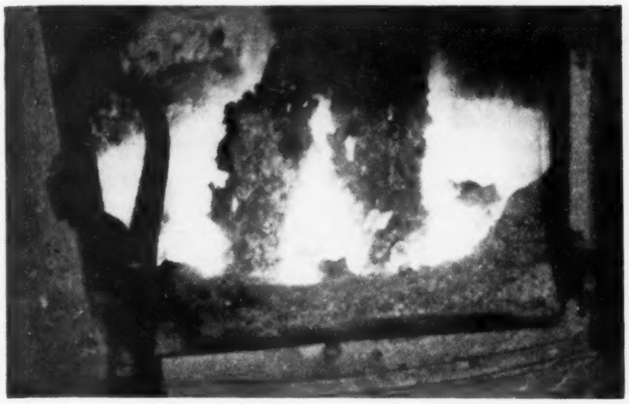


FIG. 1 TYPICAL FUEL BED IN CONVENTIONAL UNDERFEED DOMESTIC STOKER BURNING HIGHLY COKING COAL

FIG. 2 COKE-TREE FORMATION OF HIGHLY COKING COAL BURNED ON CONVENTIONAL-TYPE STOKER AFTER LONG HOLD-FIRE PERIOD

DOMESTIC STOKER *for* BITUMINOUS COAL

Stoker Designed to Burn Highly Coking Slacks and Small Sizes Without Coke-Tree Interference

By S. WILSON GUTHRIE

RESEARCH ENGINEER, ROCHESTER & PITTSBURGH COAL COMPANY, INDIANA, PA.

EVER since the introduction of the small domestic stoker designed and built for coal consumption of less than 60 or 70 pounds per hour the coal producers, the coal salesmen, and the combustion engineers working for Central and Western Pennsylvania companies have had to deal with a really difficult problem.

With very few exceptions the slacks and small-sized coals mined in Pennsylvania and suitable for use on these domestic stokers have the property which has become known to stoker manufacturers, coal operators, and finally to the homeowners as a coking or caking characteristic, which is indicative of coke-tree formation and unsatisfactory performance in the domestic-stoker field.

Fig. 1 shows a typical fuel bed in a conventional-type underfeed domestic stoker burning a highly coking coal, sized $^3/_8$ in. $\times$ $^3/_4$ in. This view was taken while the stoker was in operation after 30 to 40 minutes of continuous running. Note the coke formation and the fact that there is no active combustion except around the tuyères or at the base of the "tree." A fuel bed such as this will continue to burn and in most cases give fairly satisfactory performance in cold weather when the demands of the thermostatic controls are frequent and sustained enough to maintain ignition at the base of the coke tree. The coke formation will eventually fall over of its own weight as it becomes top heavy and will burn as coke on the grates if sufficient oxygen and temperature are available. Installations of the conventional-type stoker have been observed that gave satisfactory performance in cold weather when the thermostatic demands were high even when using the most heavily coking coals.

It is in mild weather, particularly during those periods in the year when cold nights and warm days are prevalent, that real operating troubles develop. On bank or hold-fire periods, when the system is not calling for heat, and the function of the control equipment is only to maintain ignition, and the time elapsing between "on" periods lengthens out, the density and mechanical strength of these coke trees increase rapidly.

Usually either one or the other of the following conditions develops:

The coke tree, as shown in Fig. 1, will fall over onto the grates, but there is insufficient air available to burn it or even to keep it ignited. If there is sufficient incandescent coke remaining around the tuyères, another coke tree starts to form which eventually topples over. As this process continues, in the course of 10 or 12 hours the firebox will be filled with such an accumulation of coke that the system is overloaded. Shear pins shear or the overload relay on the motor kicks out and the fire goes out.

Most highly coking coals when burned on the conventional-type stoker and subjected to long hold-fire periods develop a coke tree such as that shown in Fig. 2. The coke becomes so dense that it is impossible to force air through it. The mechanical strength of such a tree is so great that it will not topple over and in a short time an out fire results.

Contributed by the Fuels Division and presented at the Semi-Annual Meeting, Cleveland, Ohio, June 8–10, 1942, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

FIG. 3 DOMESTIC STOKERS UTILIZING BITUMINOUS COAL, SHOWING POTENTIAL MARKET FOR PENNSYLVANIA SLACKS

COKE-TREE PROBLEM MADE SUBJECT OF INVESTIGATION

This was the problem presented to the personnel in the School of Mineral Industries at Pennsylvania State College in 1939 under the Comfort Heating Project of the Co-Operative Research Program, financed jointly by the State of Pennsylvania and the coal-operators' associations of Central and Western Pennsylvania.

That such a program would be profitable to the coal industry of Pennsylvania and to the manufacturers of domestic stokers, if a solution could be found, is demonstrated in Fig. 3, which is a chart drawn up from data compiled by the Stoker Manufacturers' Association. The shaded blocks indicate the states which comprise the natural markets for Pennsylvania coals. Interpreted in simple terms the chart shows that less than 4 per cent of the domestic bituminous-coal stokers have been sold in the available markets.

Assuming that the average consumption per stoker is slightly more than 12 tons per installation and that there are more than 600,000 in operation, it is quite evident that the coal industry in Pennsylvania has not benefited from a potentially desirable market.

The personnel at The Pennsylvania State College started to work on this problem. Consideration was given to the following:

1 Why was it that Central Pennsylvania coals which were put in storage piles in September or October would not perform satisfactorily, while coal from the same pile burned with reasonable satisfaction in March or April, and if an over-run occurred the coal that had been in storage for a year gave excellent performance the next fall?

2 Why do the crop coals and coal from most of the thin cover strip mines operate satisfactorily?

3 The manufacturers of coke have known for years that coal stored for an appreciable length of time loses some of its original coking properties.

4 Coal of higher oxygen content from the Midwest and Central West gives much more satisfactory performance in the domestic-stoker field than the higher-rank Pennsylvania coals.

The facts all add up to one answer i.e., oxidation. Parr's findings,[1] as shown in Fig. 4, indicated that such a reaction is possible at relatively low temperatures, and as the temperature increases the rate at which coal absorbs oxygen increases very rapidly.

TESTS DEMONSTRATE OXIDATION TO BE A CORRECTIVE

Preliminary tests by heat-treatment of coal and on coal that had been stored for a considerable length of time showed conclusively that the coking characteristics could be altered materially, and that coals subjected to such treatment would operate with entire satisfaction on the conventional-type underfeed domestic stoker. The research staff at The Pennsylvania State College then demonstrated that sufficient oxidation could be accomplished within the stoker itself.

The first experiments were made by introducing compressed air through openings in the firepot some 5 to 6 in. below the active burning zone. It was found that, if this "preoxiding" air could be intimately mixed continuously with the coal as it moved upward in the retort, a marked decrease in the coking tendency of the coal would be effected. Without mechanical means to keep the coal and air intimately mixed, the effect of the preoxiding was negligible—the mass of coal forced upward by the horizontal or coal-feed screw being too dense to permit the air to penetrate the tightly packed mass.

The vertical screw revolving approximately $2^1/_2$ times as fast as the coal-feed screw proved to be the solution to this problem. The vertical screw is not employed as an agitator or a device to break up coke after it has formed, as contrasted with agitators incorporated by several manufacturers, but is used as the simplest and most effective method of keeping the coal and preoxiding air intimately mixed as they pass through

[1] "Industrial Coal," published by American Engineering Council, Ronald Press, New York, N. Y., 1924, section, "Chemical Factors of Deterioration," by S. W. Parr, pp. 80–91.

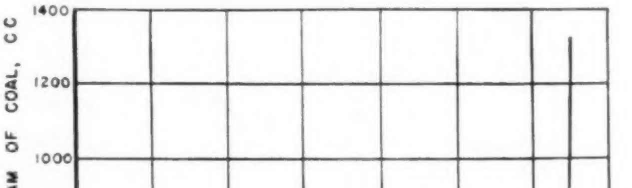


FIG. 4 RELATIVE RATE OF OXIDATION OF DRY COAL AT VARIOUS TEMPERATURES[1]

the zones where preoxiding takes place. Proof of this has been demonstrated. If the preoxiding air is shut off, coke trees immediately start to form. As previously stated, the preoxiding air will not penetrate effectively the tightly packed mass of coal in the retort unless mechanical mixing is provided.

Fig. 5 shows conclusively that the coking characteristics are greatly altered by the preoxiding air. The stoker retort was drilled at about one-inch intervals from the point at which the coal enters the retort to a point one inch below the active burning zone. Samples of the coal were taken through each of these openings with the preoxiding available and with it shut off, the stoker operating under the same load demand in both instances. The samples taken were subjected to the standard British coke-button swelling test. The upper series of buttons indicates that there was little or no change in the coking tendency in the absence of the preoxiding air, but the lower series shows definitely that the presence of the preoxiding air has a marked effect, and that the coking tendency had been destroyed almost completely by the time the coal had moved up into the active burning zone.

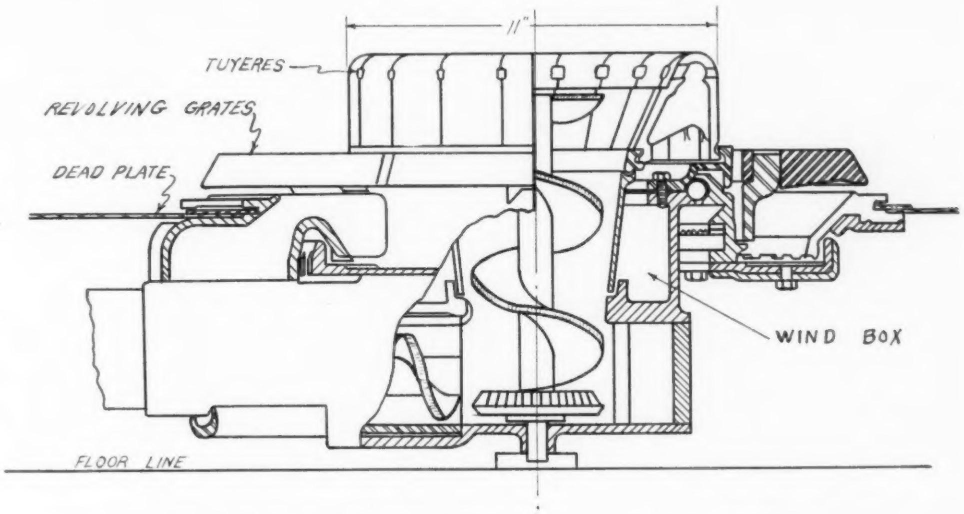


FIG. 6 BURNER-HEAD ASSEMBLY OF CONVERTED STOKER UNIT

Remarkable improvement in the fuel bed was observed and, with the proper adjustment of the air admitted through the preoxiding tuyères, coke-tree formation was completely eliminated. The entire operating cycle gave every indication of satisfactory operation, very rapid response, dependable hold-fire control, and much higher CO_2 content (13 to 15 per cent during the running periods) in the flue gases.

SELF-CONTAINED UNIT DEVELOPED TO PROVIDE OXIDATION

The next step in the development was to incorporate the principle into a self-contained unit, operating from a single drive shaft and a single fan, supplying the air for preoxidation, and the balance of the air necessary for combustion through the upper or regular tuyères. This involved some mechanical changes but several stokers of the conventional types have been converted by the staff at State College and have been operating with complete satisfaction, both in the laboratory and in home installations.

Fig. 6 shows a phantom view of one of the converted units which has been operating satisfactorily for more than a year. This unit as originally purchased had the automatic ash-removal feature built into it, and the only changes necessary to convert it to the preoxidation principle were:

1 The installation of the vertical screw.

2 A mechanical arrangement for driving the vertical screw at the proper speed in relationship to the coal-feed screw.

3 The design and installation of the lower or preoxiding tuyères.

4 A device to keep the lower air ports open. It was found that in the course of 2 or 3 days these ports became packed with fine coal, decreasing the amount of preoxiding air available, with the result that coke formation started immediately unless some such device was provided.

That these changes were effective in so far as the elimination of coke formation is concerned is shown in Figs. 7 and 8. Fig. 7 shows the fuel-bed condition after 1 hr and 45 min of continuous operation with the coal feeding at the maximum rate (20 lb per hr in this unit). Note the complete absence of coke-tree formation. The fact that the CO_2 content of the stack gases ranged from 13 to 15 per cent over this period, without visible smoke emission from the stack, is proof that the fuel-bed conditions are nearly perfect.

Coal from more than 25 mines and from 8 seams ranging in size from —28 mesh dust to $^3/_4$ in. $\times$ $1^1/_8$-in. nut coal have been burned on these converted units with uniformly satisfactory results in so far as coke-tree formation is concerned. The seams include: (1) Upper Freeport; (2) Lower Freeport; (3) Thick Freeport; (4) Upper Kittanning; (5) Lower Kit-

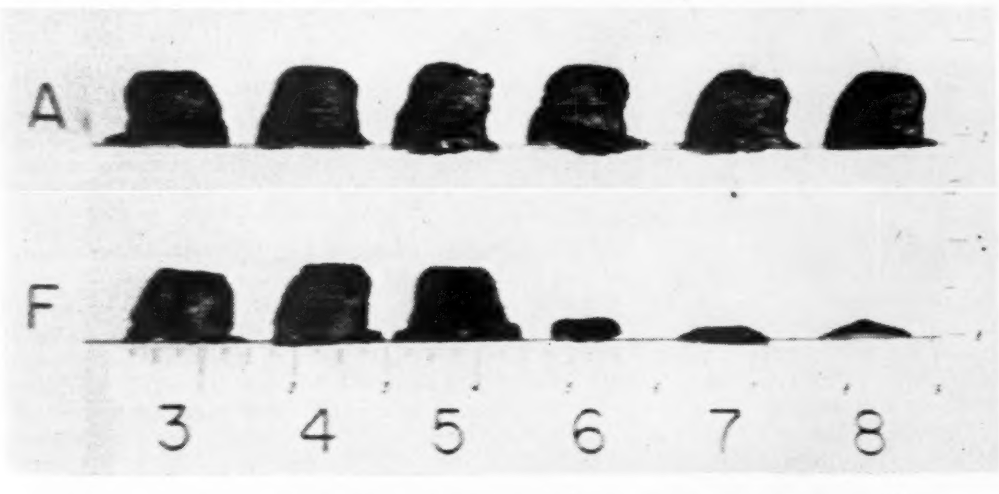
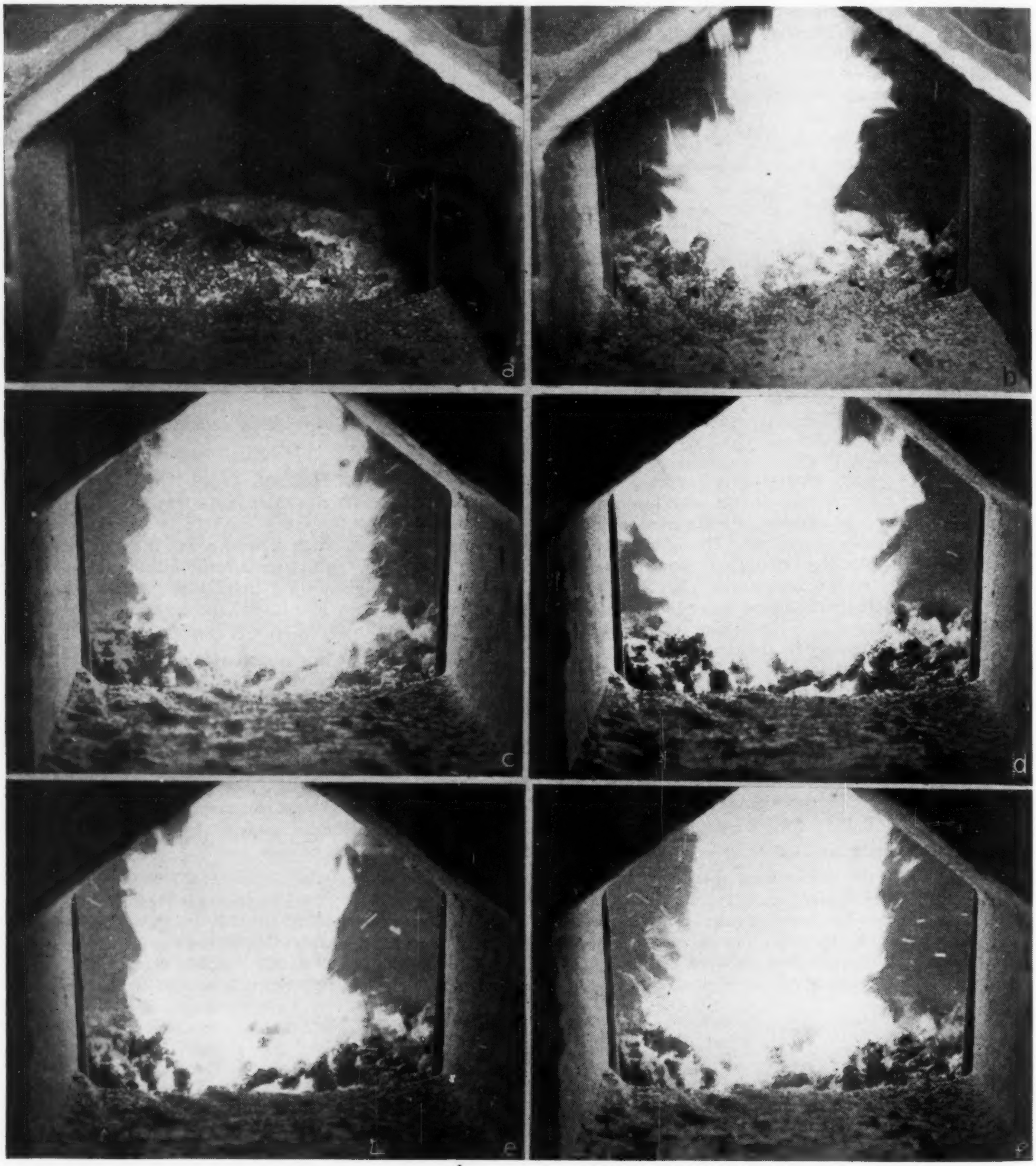


FIG. 5 EFFECT OF PREOXIDATION ON SWELLING PROPERTIES OF UPPER FREEPORT $^1/_2$ IN.



(*For caption see facing page—Fig. 8*)

tanning; (6) Pittsburgh; (7) Fulton; (8) Barnett. The volatile content of the various coals tested ranges from 15 to 37 per cent with widely varying chemical analyses.

One of the sponsoring organizations (The Rochester and Pittsburgh Coal Company) has designed and built a stoker incorporating these principles but much simpler in the construction details than those converted. This unit has been in service in a domestic residence, installed in a hot-water boiler with slightly more than 1100 sq ft of radiation surface in the system, which has no forced circulation. The results over the past heating season were completely satisfactory from the viewpoint of combustion, responsiveness to load demands, ease of control, and lack of objectionable coke formation.

Outdoor temperatures ranging from —13 F to 64 F were observed over the heating season with living-room temperature fluctuations of ±2 deg. Burning rates varied from an average high of 13 lb of coal per hr to a low of less than 2 lb per hr over 24-hr periods. In extremely mild weather ignition was maintained for weeks with coal consumption less than 1 lb per hr.

An indication of the type of fuel bed obtained when burning a coking coal in this unit and a graphic picture of the rapidity

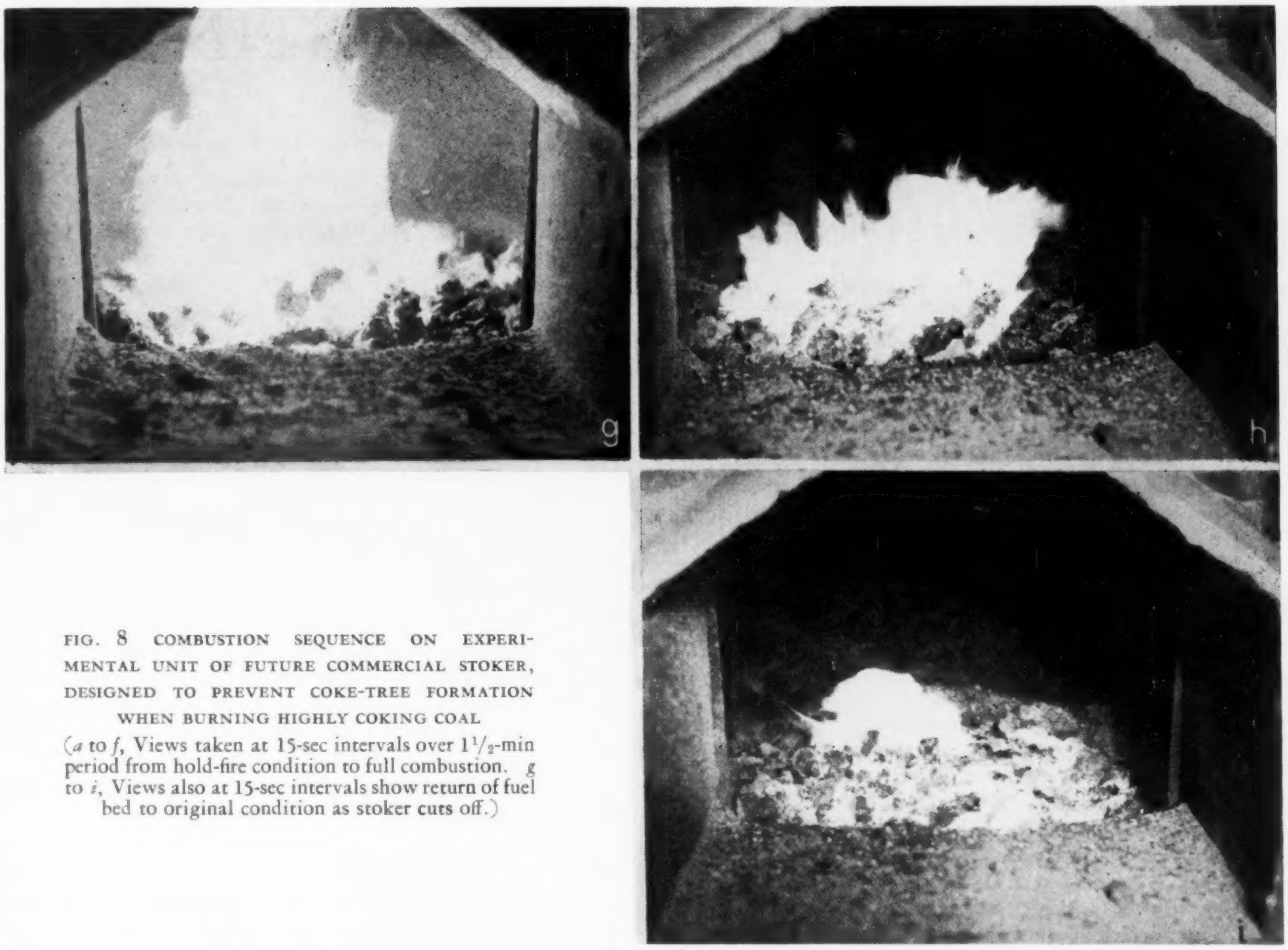


FIG. 8 COMBUSTION SEQUENCE ON EXPERIMENTAL UNIT OF FUTURE COMMERCIAL STOKER, DESIGNED TO PREVENT COKE-TREE FORMATION WHEN BURNING HIGHLY COKING COAL

(*a* to *f*, Views taken at 15-sec intervals over $1^1/_2$-min period from hold-fire condition to full combustion. *g* to *i*, Views also at 15-sec intervals show return of fuel bed to original condition as stoker cuts off.)

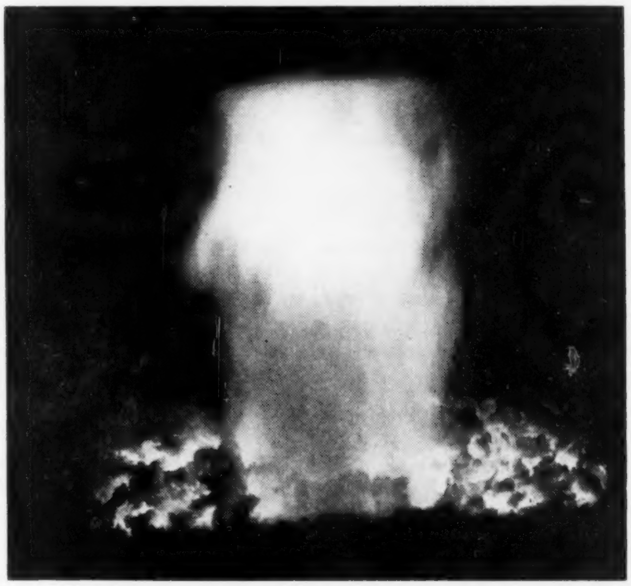


FIG. 7 CONDITION OF FUEL BED AFTER ONE HOUR AND 45 MINUTES OF CONTINUOUS OPERATION

(Coal feeding at maximum rate of 20 lb per hour in this unit. Note the complete absence of coke-tree formation.)

of response to thermostatic demand is shown in the sequence Fig. 8. Views (*a*) to (*f*), inclusive, of Fig. 8 were taken at 15-sec intervals, starting from a complete bank or hold-fire condition through slightly more than $1^1/_2$ min of running time. Views (*g*) to (*i*), inclusive, also taken at 15-sec intervals, show how the fuel bed returns to its original level condition as the stoker cuts off.

In conclusion, the coking properties of the strongly coking Pennsylvania coals can be modified by the introduction of a portion of the air necessary for combustion at a point 6 to 8 in. below the active burning zone. If this air is continuously and intimately mixed with the coal, as the temperature increases, sufficient oxidation takes place to result in the elimination of coke-tree formation and greatly improved operation.

MECHANICAL HARVESTING *of* COTTON

As Affected by Varietal Characteristics

By H. P. Smith[1] and D. T. Killough[2]

In the present war great quantities of cotton products are required to bring it to a successful conclusion. Cotton fiber is needed to clothe our soldiers and sailors wherever, throughout the world, they are called upon to fight. Products of cotton play an important part in feeding our fighting forces both directly and indirectly; directly to season and cook the food, and indirectly as feed for livestock which provides meat for our fighting forces. Then, too, cotton is essential for the manufacture of ammunition to carry on the battle and destroy the enemy.

To supply this need cotton must be produced in large quantities. Cotton cannot be produced overnight nor within a week or a month. It requires a full season of 6 months to grow a crop of cotton from planting to harvest. More labor and power are required to grow cotton than any other field crop the farmer plants. For example, to grow an acre of cotton with one-row horse-drawn equipment, it requires 25.5 man-hours and 23.5 horse-hours. Of this, 10.45 man-hours are needed prior to harvesting and 15.05 for the harvest. Where two-row tractor equipment is used it requires a total of 20.25 man-hours and 3.65 tractor-hours. Prior to harvesting, 5.5 man-hours are required and 14.75 for the harvest. At the present time there is not sufficient man power for growing and especially for the harvest; this situation will become more serious in the months to come. Hence there is considerable interest in the factors that affect mechanical harvesting of cotton.

TREND TOWARD FARM MECHANIZATION

During the last decade there has been a tremendous movement toward mechanization on the farm; so much so that machines have taken the swing out of the small-grain harvest, the rhythm of the bang board from the corn harvest, and the stoop out of the beet harvest, but the drudgery of the cotton harvest with its blistered necks, aching backs, and sore knees is still with us. Cotton is picked today as it was picked by the Children of Israel while slaves of Pharoah in Egypt thousands of years ago. Why? It has not been for lack of effort on the part of engineers and inventors; because hundreds of patents have been granted on various devices related to cotton-picking machines. In general, these devices may be classified as pneumatic and mechanical or a combination of the two. The mechanical types may be subdivided into picker and stripper types. The picker type removes the cotton from the bur, while the stripper type removes both the cotton and the bur, which must be separated or extracted with other machinery.

MECHANICAL COTTON HARVESTER

In order that the relation of the machine to the cotton plant may be more fully understood, the functions of the machine will be briefly outlined. From the mechanical standpoint, not considering field topography, soil and weather conditions, or varietal characteristics, there are several basic requirements of a mechanical cotton harvester; these are as follows:

1 It must harvest at least 95 per cent of the total yield.

2 The cotton must be harvested with a minimum of trash and foreign matter.

3 The separation and cleaning of any trash or foreign matter collected with the cotton should start as quickly as possible after it is removed from the plant.

4 If the machine is of the picker type it must not seriously injure either the growing plant or the bolls.

5 The capacity of the machine must be sufficient to compete with hand picking.

6 The quality of the mechanically harvested cotton should be practically equal to that of hand-harvested cotton.

7 The machine must be of sound design and as simple as efficient operation will permit.

8 Preferably a mechanical cotton harvester should be a tractor attachment rather than a self-propelled machine.

Some of the machines of the past have been well designed, but Nature, in creating the cotton plant and its characteristics, and aided by the prejudice of mankind, prevented these machines from being a success. As the years rolled along, men learned more and more of the requirements of a successful cotton harvester and have come to the realization that for the machine to be successful they must consider the various plant characteristics that affect machine operation, some of which are listed as follows:

1 The cotton crop does not ripen or the bolls open within a very short period like most field crops.

2 The cotton hangs in the bur rather closely, making it difficult for any mechanical device to remove it from the bur.

3 As the crop does not ripen uniformly the first and early-opened cotton deteriorates at least a grade for every 4 weeks it remains in the field, and sometimes more rapidly.

4 It is very difficult to remove the cotton from the plant while in full foliage without also removing with it parts of leaves and other foreign matter.

5 The size of the cotton plant may vary to such an extent that it is difficult to construct a machine that will be equally efficient in harvesting cotton from small plants only a few inches in height and from large plants 5 or 6 ft tall and with a limb spread of 3 or 4 ft.

6 Some of the cotton bolls are either resting on the ground or only a few inches above it. This makes it difficult for any mechanical device to operate at a low enough level to harvest these low bolls.

7 There are so many different varieties of cotton grown in

[1] Chief, Division of Agricultural Engineering, Texas Agricultural Experiment Station, A.&M. College of Texas, College Station, Texas.
[2] Agronomist, Division of Agronomy, Texas Agricultural Experiment Station, A.&M. College of Texas, College Station, Texas.
Contributed by the Textile Division and presented at the Spring Meeting, Houston, Texas, March 23–25, 1942, of The American Society of Mechanical Engineers.

various sections of the cotton belt, each having different characteristics, that it is not easy to build a machine adapted to such wide variations.

DIFFICULTIES OF HARVESTING COTTON MECHANICALLY

As a general rule, varieties of cotton commonly grown have numerous long vegetative branches making an excessive amount of foliage which often interferes with the operation of the harvesting machine. It has been found that certain varieties are better adapted to mechanical harvesting than others. In fact, we have found in our experiments that there will be as much as 15 per cent difference in the efficiency of the machine in harvesting different varieties grown under the same conditions in the same field. Engineers working on corn pickers have found that some varieties of corn, and especially the hybrid strains, give higher machine efficiencies than other varieties. An engineer of a large implement-manufacturing company recently stated that corn hybrids, because of their better uniformity, have done more to popularize the mechanical corn picker in the corn belt than any other one factor. Corn, like most field crops, ripens uniformly enough so that it can be harvested in one operation, while cotton, on the other hand, may start blooming and putting on bolls in June and continue until frost. From bloom to maturity and opening of the boll requires about 45 days. Consequently machine harvesting of the early-open cotton without injury to the plant and the immature bolls is quite a problem. On the other hand, if harvesting is delayed until practically all the bolls are open, the early cotton will deteriorate. Thus it can be readily seen that the engineer needs the assistance of the cotton breeder to produce types of cotton plants that are more suitable for mechanical operation.

INFLUENCE OF VARIETAL AND PLANT CHARACTERISTICS

The influence of varietal and plant characteristics of cotton on the efficiency of mechanical harvesting was not fully realized until a few years ago. Many well-designed cotton-harvesting machines may have failed to give satisfactory performance largely because varietal characteristics were not given due consideration. The engineers and inventors looked upon all varieties of cotton as just cotton, and apparently did not realize that there is relatively as much difference in varieties of cotton as there is in breeds of some animals. The engineer is naturally mechanically minded and is ambitious to design a machine that will do a perfect job of harvesting anywhere under any condition. He overlooks the fact that cotton plants may vary from a small plant less than 1 ft tall to plants that may be 6 ft or more in height. The small plant may not spread horizontally as much as the span of your hand, while the large plant may have a limb spread of 3 or 4 ft. The average plant, however, will range in height from 2 to 3 ft and have a spread of 20 to 30 in. The engineer can test his machine on available varieties of cotton, observing desirable and undesirable qualities. He then outlines the required plant characteristics to the plant breeder who attempts to develop strains to meet the requirements.

From the very beginning of our work it was recognized that the efficiency of any mechanical harvesting device would be greatly affected by plant characteristics. Consequently we began studying plant characteristics, such as storm resistance, the length and number of fruiting and vegetative branches, size and type of leaves, size of bolls, height of plant, and fiber characteristics. Breeding work was started by crossing and selecting desirable types. One cross resulted in a strain which had only a central axis stalk with very short false limbs on which the bolls were borne in clusters. It was thought this type would meet the necessary requirements but, after testing its reaction to machine harvesting and extracting, it was found that the large stems made the bolls hard to remove and the clusters of burs did not readily pass through the extractor. The machine harvested the cotton readily, but the boll stems were so large that they broke off at the plant rather than the bolls breaking at the boll end of the stem. It required an average of 9 to 10 lb pull to detach the bolls from the plant. After this experience and after testing numerous varieties possessing variable characteristics, it appeared that an ideal plant type for all methods of harvesting is one having relatively short-noded fruiting branches 8 to 10 in. long, no vegetative branches, open-type growth, light foliage, storm resistance, and a medium to large strong boll borne singly on a peduncle that will snap easily under tension but will withstand plant agitation.

One adverse characteristic may be of such nature that it will offset many good qualities. For example, if a variety produces numerous long branches that overlap between rows, it would be difficult for any mechanism to harvest all the cotton from such a mass of vegetation folded into a narrow space only a few inches wide, even though all other characteristics, such as boll size, fluffiness, storm resistance, and fiber type were excellent for mechanical harvesting.

DESIRABLE STRAINS RECENTLY DEVELOPED

The Texas Station cotton breeders have recently developed strains of cotton possessing desirable qualities for harvesting, extracting, and cleaning. A cotton harvester of the stripper type known as the Texas Station harvester has been developed and used by the Division of Agricultural Engineering on the Texas Station for several years to test commercial varieties of cotton possessing variable characteristics and hybrid types in which certain desirable characteristics have been recombined in the breeding process. Results of these tests show that plants of medium height can be harvested more readily than plants with tall rangy growth. The tops of tall plants will not pass through the stripping rolls of the Texas Station harvester before they reach the rear end of the rolls, and other tall plants press against them and form a mass of vegetative material, and cause much foliage to be stripped off into the harvested cotton thus lowering its quality or grade.

Furthermore a number of short short-noded branches are more desirable than a few long branches with the bolls spaced farther apart. One or two long branches that start near the base of the plant can cause the loss of more cotton with the Texas Station type of stripper harvester than twice as many short branches uniformly spaced over the plant.

Varieties characterized by a dense foliage with great numbers of large stems hinder the operation of mechanical strippers and pickers by folding over the bolls of cotton, thus making the removal of cotton from the plants difficult. Dense foliage shades the bolls, frequently delaying their opening. In damp weather such foliage may cause a loss of cotton by rotting of bolls, which would also lower the quality of the cotton containing such bolls.

Other characteristics, such as the size, shape, and storm resistance of bolls, have an influence on the quality of cotton whether harvested by hand or by machinery. Large five-lock bolls are much more suitable than small four-lock bolls for both mechanical stripping and picking. In stripping, the large bolls are usually stronger, more easily snapped off, and are more readily thrown from the stripping units into the conveyer trough with less loss than small bolls. The cotton in the large bolls expands and fluffs out so that the picker units in the picker-type machine can engage the cotton more readily and remove it from the boll. Long pointed bolls do not seem to open as wide as the more rounded blunt bolls, and it is therefore more difficult to extract the cotton from such bolls. In some varieties the

boll sections do not spread apart more than 90 deg, while in others the spread may be as much as 150 deg. It is rare to find a boll where the spread of the boll equals 180 deg. A boll spread ranging around 120 deg will usually extract well yet have enough storm resistance to prevent the cotton shedding during wind and rain storms.

DETAILED QUALITIES TO BE BRED INTO COTTON PLANTS

Storm resistance is of prime importance in a variety of cotton regardless of the method of harvesting. In using the stripper type of machine, it is necessary to allow all of the cotton on the plant to open before harvesting. For this reason a variety must possess good storm resistance to be adapted to stripping. Cotton hanging loose in the boll often falls out and is lost with the slightest jar to the plant by the machine in harvesting. A strain known as Macha has such storm resistance that it is difficult to pick by hand. In fact it requires twice as much time to harvest this variety by hand than others; it is also very difficult to extract.

Earliness of maturity and a shorter fruiting period are important characteristics in the mechanical harvesting of cotton. Slow-growing late-maturing varieties having long periods of opening, are not well suited to machine harvesting, as they usually possess an excessive vegetative growth.

Single bolls spaced fairly close together are more satisfactory for all methods of harvesting. Bolls borne in clusters are difficult to pick by hand. Furthermore the clusters will not readily pass through the extractor and it is difficult for the mechanical picker to handle such a compact mass of cotton.

Character and length of fiber greatly affect the cleaning qualities of cotton, as reflected in the grade of cotton picked and snapped by hand and harvested by the Texas Station stripper. For example, the average grade of the longer staple fine-fibered variety represented by Ducona, was one grade lower than the short staple coarse-fibered variety, represented by Mebane 140, which graded strict low middling when harvested by the Texas Station harvester at College Station during the four years 1938 to 1941, inclusive. In 1940, there was a difference of three grades between the two varieties harvested with the stripper. Even greater difference in grade existed between Half and Half with a shorter and coarser fiber than Mebane 140, and the fine-fibered Ducona for the three years, 1939 to 1941, inclusive, when harvested by the Texas Station harvester at College Station. Less difference in grade was noted between the varieties differing in fiber characteristics when picked by hand and snapped by hand, as compared with machine harvesting, although there was a tendency for the grade to be lower in the case of the longer finer-fibered Duncon for either of these two methods of harvesting by hand. Somewhat similar results were obtained at Lubbock but the differences in grade between the varieties was not as pronounced. This may be attributed largely to the fact that the plants at Lubbock are smaller and can be harvested more efficiently with the machine. Furthermore the period of boll opening is not as long before harvesting as at College Station, and consequently the open cotton is not exposed to weather conditions for as long a period of time.

The differences in grade seemed to be closely associated with such boll and fiber characteristics as compactness of the locks, interseed fiber drag, character of the fiber, whether short or long, coarse or fine, and the density of fiber on the seed. Varieties having compact locks, with good interseed fiber drag, with medium-to-short and medium-to-coarse fiber, and with fibers dense on the seed, cleaned better, and the trash separated more readily from the cotton than did varieties lacking in these characteristics.

A knowledge of the effect of various varietal characteristics and seasonal conditions reveals why there have been so many failures of mechanical cotton harvesters and also why agricultural leaders and cotton growers of the South are slow to accept the mechanical cotton harvester for the commonly grown varieties. We cannot expect a cotton-harvesting machine to harvest cotton from all varieties grown with equal facility. Those varieties that the machine can harvest best may not give the highest yields. Therefore in order for a mechanical cotton harvester to operate successfully and be acceptable, it is necessary to grow well-adapted varieties for the purpose and to practice methods of culture that will aid the machine in its operation. The cotton grower must accept the fact that he cannot expect the machine to gather 100 per cent of his cotton. He must take a slight loss as is done by the grain grower harvesting his crop with the combine and the corn grower harvesting his crop with the mechanical corn picker.

Courtesy Buick

CONVERSION FOR VICTORY

LOAD RELATIONS *in* BOLTED JOINTS

By THOMAS J. DOLAN

ASSOCIATE PROFESSOR OF THEORETICAL AND APPLIED MECHANICS, UNIVERSITY OF ILLINOIS

INTRODUCTION

In THE design of an assembly of two or more metal sections fastened together with bolts, some designers assume that the compression members of the assembly are rigid and do not deform when the bolts are tightened. However, no metal sections are incompressible, though they may be very stiff, and the interactions which occur should be considered in the design and allowed for in service.

The extent to which the load on a bolt is increased by the application of an external force to the joint depends partly upon the magnitude of the external force and in part upon the relative stiffness of the bolt, as compared with that of the members joined by the bolt. For members subjected to repeat applications of loads in service (such as connecting rods in an internal-combustion engine) the magnitudes of the fluctuating loads transmitted to the bolt are of primary importance in design since excessive repeated loads on the bolt will lead to a fatigue fracture.

The subsequent discussion presents equations for the distribution of loads and deformations in a bolted assembly and for total loads carried by the bolt for the case in which the bolt is subjected to axial loads only.

ASSUMPTIONS AND NOTATIONS USED

Let it be assumed that the bolt and the members joined are perfectly elastic and that all parts conform with Hooke's law, that is, the parts will develop only elastic deformations in either tension or compression which vary directly with load. The load on any portion of the joint may then be expressed as equal to some stiffness constant k, multiplied by the elongation of the part. Hence the initial bolt tension T, may be expressed as

$$T = k_2 e_2 \qquad [1]$$

where

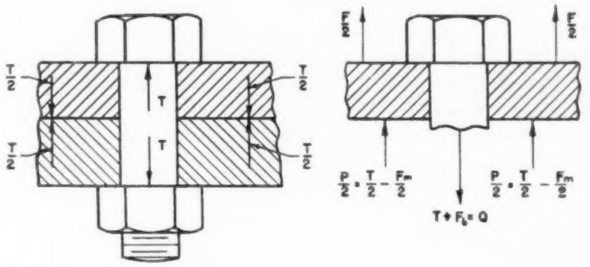
e_2 = elongation of bolt, in.

and

k_2 = stiffness constant for bolt

expressed as $\dfrac{\text{load}}{\text{elongation}}$, lb per in.

For any typical bolted assembly, the stiffness of a specific part may be measured experimentally and expressed as the ratio of a load increment divided by the corresponding measured increment of strain over the effective length of the part, assuming that the nature of loading is representative of the conditions to which the part is subjected in the bolted assembly. The stiffness of the bolt is influenced to some extent by localized deformations due to bending of the threads, and warping or flexing of the nut and the bolthead sections. These effects may be aggravated in some instances by poor thread cutting or by a lack of squareness producing improper fit at bearing faces of nut and bolthead which result in additional flexing of the parts. Similarly, the apparent stiffness of the members joined is influenced to an indeterminate, and in some cases an appreciable extent by surface roughness, lack of squareness and quality of fit, foreign particles and burrs on the surfaces joined. The addition of a gasket between the members joined would decrease the stiffness of the assembly held by the bolt, but the deformations of the gasket material probably would not vary in direct proportion to the load as assumed in the analysis.



(a) Forces on joint subjected to initial bolt tension

(b) Forces on joint subjected to initial bolt tension and external load

FIG. 1 FORCES ON JOINT

In analyzing the bolted member shown in Fig. 1, it is assumed that the initial clamping tension T in the bolt is increased by an amount F_b, and that the total pressure between the bolted members is decreased by an amount F_m, when an external service load is applied to the members joined.

NOMENCLATURE

The following nomenclature is used in this paper:

e_1 = strain in members joined caused by initial bolt tension T, in.

e_2 = elongation of bolt caused by initial bolt tension T, in.

e_b = elongation of bolt due to load F applied to members joined
= strain in members joined due to load F, in.

e = longitudinal movement of nut on bolt during tightening, divided by effective grip length of bolt, in.

F = external tensile load added to members joined, lb

F_b = added bolt tension caused by load F on joint, lb

F_m = decreased compression between members joined due to added load F, lb

F_0 = external load required to open joint (or make $F_m = T$), lb

F_R = fatigue endurance limit of bolt for completely reversed cycles of axial load, lb

k_1 = stiffness of member joined = $\dfrac{\text{load}}{\text{elongation}}$, lb per in.

k_2 = stiffness of bolt = $\dfrac{\text{load}}{\text{elongation}}$, lb per in.

Presented at the Fourteenth National Meeting of the Oil and Gas Power Division, Peoria, Ill., June 17–19, 1942, of The American Society of Mechanical Engineers.

T = initial tension in bolt caused by tightening nut
 = initial compression in members joined, lb
$P = (T - F_m)$ = total pressure between members joined, lb
$Q = (F_b + T)$ = total tension in bolt, lb
$\mu = T/F$ = ratio of initial bolt tension to external applied load

STRAINS DEVELOPED BY TIGHTENING NUT ON BOLT

The action of the joint when tightening the nut may be visualized as shown in Fig. 2, in which the spring having a stiffness k_2, represents the bolt, and the longer spring of stiffness k_1 represents the members clamped by the bolt. Tightening the nut is analogous to joining the ends of the springs at B, developing a tension T in the bolt and a compression of value equal to T, in the members, thereby introducing a corresponding tensile strain e_2 in the bolt and a compression strain e_1 in the members joined. Hence

$$T = k_1e_1 = k_2e_2 \qquad [2]$$

and

$$e_1 + e_2 = e \qquad [3]$$

$$\therefore e_2 = \frac{k_1}{k_2}e_1 \qquad [4]$$

and from Equations [3] and [4]

$$\therefore e_2 = \frac{k_1}{k_2 + k_1}e \qquad [5]$$

similarly

$$e_1 = \frac{k_2}{k_2 + k_1}e \qquad [6]$$

and

$$T = k_2e_2 = \frac{k_1k_2}{k_1 + k_2}e \qquad [7]$$

The initial load T develops relative deformations in the members and bolt which may be expressed by the ratio (e_1/e_2). By rewriting Equation [4], it will be observed that this ratio varies in direct proportion to the stiffness ratio (k_2/k_1) of the elements making up the joint.

ADDED BOLT TENSION DEVELOPED BY EXTERNAL LOAD ON JOINT

If now an external service load F is applied to the joint, the structural action is assumed to be similar to that of two springs fastened together at their ends and loaded as shown in Fig. 4. The springs elongate the same amount e_b and hence each must develop an added force equal to its stiffness constant multiplied by e_b. The total force added in the two springs must balance the external load F. Therefore

$$F = k_1e_b + k_2e_b = (k_1 + k_2)e_b \qquad [8]$$

in which e_b = added elongation of bolt or of members joined and caused by the force F only. The members are thus in parallel and their combined stiffness $(k_1 + k_2)$ is effective in resisting the force F. Also

$$F_b = k_2e_b = \text{tension added in bolt by force } F$$

and

$$F_m = k_1e_b \qquad [9]$$

which equals decrease of compressive force between members joined. Hence

$$\left.\begin{aligned} F_b &= \frac{k_2}{k_1 + k_2}F = \frac{1}{1 + (k_1/k_2)}F \\ F_m &= \frac{k_1}{k_1 + k_2}F = \frac{1}{1 + (k_2/k_1)}F \end{aligned}\right\} \qquad [10]$$

and

$$\frac{F_b}{F_m} = \frac{k_2}{k_1} \qquad [11]$$

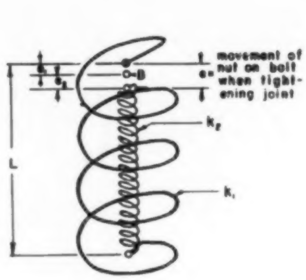


FIG. 2 ACTION OF JOINT WHEN TIGHTENING NUT

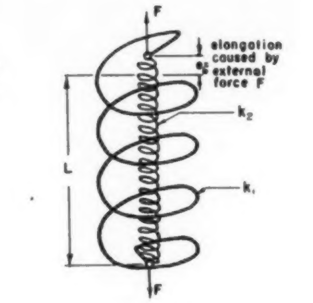


FIG. 4 ACTION OF JOINT WHEN EXTERNAL LOAD IS APPLIED

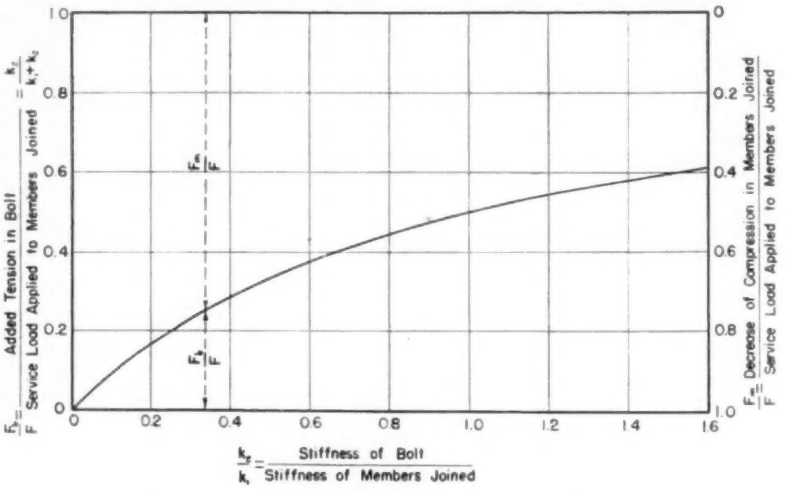


FIG. 3 DISTRIBUTION OF LOAD IN BOLTED JOINTS

Consequently the proportionate distribution of the added external load to the bolt and to the members joined is directly related to the stiffness ratio (k_2/k_1). The manner in which the load F_b on the bolt varies for different stiffness ratios is shown graphically in Fig. 3. This figure and some of those shown later have been plotted in terms of dimensionless ratios for joints varying over rather wide stiffness ratios. It is of particular interest to note that the added tension F_b in the bolt is independent of the initial bolt tension and is a function only of the stiffness ratio (k_2/k_1) and the external load F.

For any particular joint having a definite stiffness ratio the solutions of the foregoing equations may be obtained by the simple graphical representation shown in Fig. 5. In this figure the line OD is drawn to represent the load-strain relationship for the bolt and line O_1E shows the corresponding load-strain relationship for the members joined. The ordinate to the point of intersection B, gives the initial bolt tension and the projections of these lines on the horizontal show the initial strains e_2 and e_1 developed in tightening the nut. For a smaller initial bolt tension the line O_1E would be moved to a parallel position such as that shown through point B_1. If now an external force F is added to the assembly its magnitude may be laid off as a vertical line CD and the intersection D determines the maximum total tension in the bolt, whereas the ordinate to point C determines the total pressure P still remaining between the members joined.

The relationships as given assume that the added force F_m tending to separate the members does not exceed the initial compression T between the members. If F_m is greater than T the joint opens and the total bolt tension Q becomes equal to F. Hence the maximum service load F_0 that may be applied without separating the members may be computed for this limiting

condition by equating $T = F_m$, and solving for the corresponding external load on the joint. Thus

$$\text{Maximum } F_m = \frac{k_1}{k_1 + k_2} F_0 = T$$

and

$$F_0 = T[1 + (k_2/k_1)] \ldots\ldots\ldots\ldots [12]$$

Therefore the maximum holding capacity of the assembly is directly proportional to the initial bolt tension T and increases somewhat as the relative bolt stiffness (k_2/k_1) increases.

The total tension carried by the bolt may be obtained by adding the initial bolt tension to the computed service loads F_b. For convenience let $(T/F) = \mu$, that is, the initial bolt tension is made μ times the expected external load on the joint. From Fig. 1(*b*) and Equation [10]

$$Q = F_b + T = \frac{k_2}{k_1 + k_2} F + T = \frac{(k_2/k_1) \times T}{1 + (k_2/k_1)} + T \ \ldots [13]$$

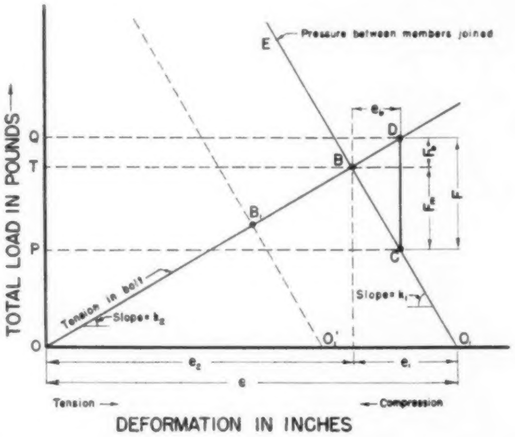


FIG. 5 DISTRIBUTION OF LOADS AND STRAINS IN A BOLTED JOINT

or

$$Q/T = 1 + \frac{1}{\mu} \times \frac{(k_2/k_1)}{1 + (k_2/k_1)} \ldots\ldots\ldots\ldots [14]$$

Equation [14] may also be rewritten in terms of F by substituting $T = \mu F$ as follows

$$Q/F = \mu + \frac{(k_2/k_1)}{1 + (k_2/k_1)} \ \ldots\ldots\ldots\ldots [15]$$

The values obtained from Equation [15] have been plotted as solid lines in Fig. 6 to show the manner in which the total tension in the bolt varies for different stiffness ratios (k_2/k_1) and the load ratios $\mu = (T/F)$. It will be observed that for a given load F the total tension in the bolt is controlled mainly by the magnitude of the initial bolt tension.

The dotted lines in Fig. 6 represent the values of the ratio (F_0/F) obtained from Equation [12] by substituting $T = \mu F$. This ratio is a factor of safety by which the applied load F must be increased before the joint is in danger of opening. Thus, for low initial bolt tension ($\mu = {}^3/_4$) the joint actually opens under the service load [where $(F_0/F) < 1$] with low stiffness ratios (k_2/k_1), but for high bolt tension (μ = 2 or 3) the applied design load would have to be increased 2 to 4 times before the joint would open. These curves are based on the assumption that the bolt does not yield under the maximum loads. With high initial tension many bolts would be stressed to values close to the elastic limit; and consideration must be given to the fact that any added external load on the members may cause the bolt to yield plastically.

In connection with this point the curves in Fig. 7, are of interest. The solid curves in this figure are values obtained from Equation [14], and the dotted horizontal lines are values of total bolt tension at which plastic deformation of the bolt would occur if tightened with an initial tension equal to 0.9 of the elastic limit, or 0.8 E.L., etc. for the bolt. The elastic limit of the bolt should be considered as the load required to produce a small but measurable permanent elongation between the gripping faces of nut and bolt even though this plastic deformation may be localized over small areas such as at the roots or faces of the screw threads.

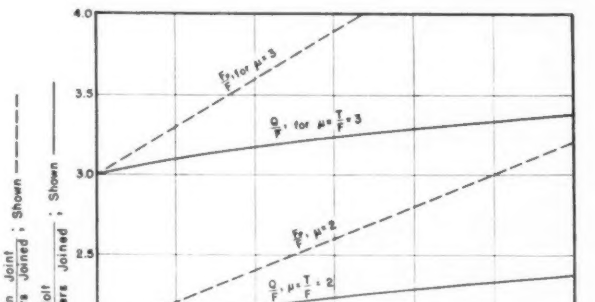


FIG. 6 MAXIMUM BOLT LOADS AND SERVICE LOADS

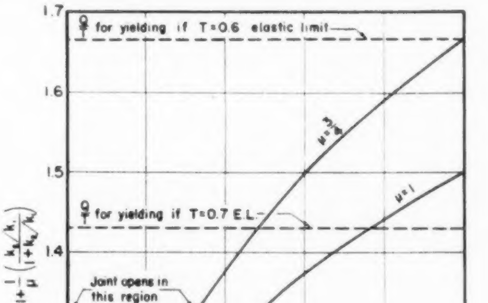


FIG. 7 MAXIMUM LOADS ON BOLTS

Several hypothetical cases will perhaps best serve to illustrate the type of information concerning a bolted assembly that may be obtained from Figs. 5 to 7.

DISCUSSION OF RESULTS

Case 1. Assume that a given bolted assembly is designed to sustain an external load of 10,000 lb and that the bolt is tightened with an initial tension of 7500 lb [$\mu = (T/F) = {}^3/_4$]. The stiffness of the bolt is found to be 0.4 times the stiffness of the members joined, and the material of the bolt is such that the tensile elastic limit of the bolt is 12,500 lb. From Fig. 7, the curve for $\mu = {}^3/_4$ indicates that the maximum load sustained by the bolt would be $(Q/T) = 1.38$, or $Q = 10{,}350$ lb, which is still below the elastic limit. For this case the value of the initial tension in the bolt is 0.6 times the elastic limit and the horizontal line for $T = 0.6$ elastic limit in Fig. 7, would indicate that (Q/T) must be increased to 1.67 before the bolt would yield. However, either Fig. 6 or Fig. 7, would indicate that this joint is in danger of opening under load if either the initial tension were decreased slightly or the external load were increased over that assumed in the design.

Case 2. If this bolt is tightened to a greater initial tension of 10,000 lb (that is $T = 0.8$ E.L. and makes $\mu = 1$), the value for $(Q/T) = 1.285$ in Fig. 7, which is above the line for yielding. Hence this bolt would be unsatisfactory in service.

Case 3. If the joint could be modified to decrease the relative stiffness (k_2/k_1) to a value of, say, 0.2, the same bolt would not yield under these conditions since the value of (Q/T) is reduced to 1.165, that is, the maximum load on the bolt is 11,650 lb which is below the elastic limit of 12,500 lb.

The joint is able to withstand a much greater external load without opening when the initial bolt tension is increased from 7500 to 10,000 lb. However, for $F = T = 10{,}000$ lb the decrease in relative stiffness (k_2/k_1) from 0.4 to 0.2 also decreases the factor of safety against opening from 1.4 to 1.2, that is, the joint would open in the latter case if the external load were increased 1.2 times to 12,000 lb.

Case 4. Since the bolt, discussed in case 3 leaves such a small factor of safety against opening of the joint, assume that it is felt advisable to double the area of the bolt and still set the initial tension to 0.8 of the elastic limit. Thus the initial tension is about 20,000 lb, making $\mu = 2$. Increasing the area of the bolt probably would also increase the ratio (k_2/k_1) to about 0.4. With these data the curves in Figs. 6 and 7 indicate that the factor of safety against opening of the joint is increased to about 2.8, but the maximum tension in the bolt would still be too high; $Q = 22{,}800$ lb, whereas the elastic limit is 25,000 lb.

Case 5. Hence it would seem desirable to lower the initial tension on this bolt to about 15,000 lb (or 0.6 E.L.), making the total tension in the bolt about 17,900 lb and leaving an adequate factor of safety (about 2.1) against the opening of the joint.

Perhaps a simpler method of illustrating the variations discussed in the five hypothetical cases given, is to plot the data on a diagram of the type of Fig. 5. This has been done for these same five cases in Fig. 8, using the same notations for the points O, B, C, D, etc., as those used in Fig. 5 except that the subscripts 1, 2, 3, 4, and 5 have been used to designate the respective cases as numbered. As previously explained, the point B represents the initial bolt tension, D the total bolt tension, and C the minimum pressure between the members joined when a force $F = 10{,}000$ lb is added to the assembly. The tension in the bolt of smaller stiffness (case 3) is represented by a line OD_3 of smaller slope than the line OD_4 for the other four cases discussed. For each case the ordinates to the points C may be compared as a measure of the compression remaining in the joint to resist opening, whereas the ordinates to the points D

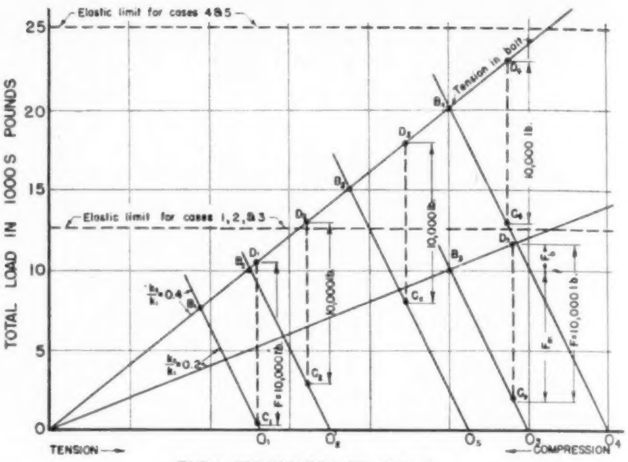


FIG. 8 INFLUENCE OF BOLT STIFFNESS AND INITIAL TENSION ON LOAD DISTRIBUTION IN JOINT

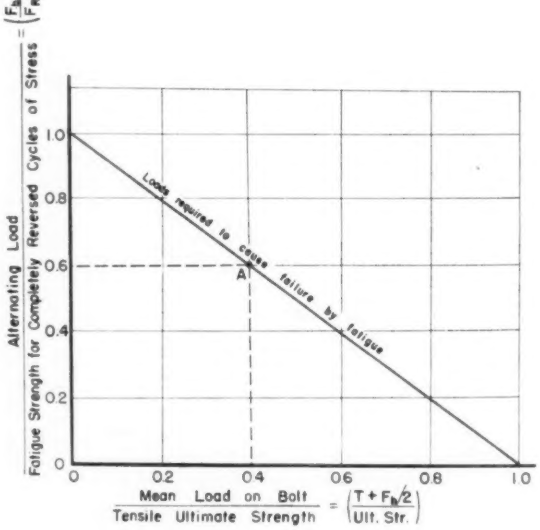


FIG. 9 RELATION BETWEEN MEAN STRESS AND ALTERNATING STRESS REQUIRED TO CAUSE FRACTURE OF BOLT

may be compared directly with the elastic limit of the bolt to judge the relative nearness to failure by plastic deformation.

If the external load is repeatedly applied and removed a great number of times during the normal life of the member, there is also danger of the bolt failing by a progressive fracture (fatigue failure). Many of the bolts and studs in a reciprocating mechanism are subjected to this type of loading, and fatigue failures of bolts due to improper loading in service are not uncommon. For repeated loading, the diagram, Fig. 9, shows the relationship between the mean or steady load on the bolt $(T + F_b/2)$, and the completely reversed alternating component of the bolt load $(F_b/2)$, required to cause a fatigue fracture.

This diagram is based on the results of a large number of laboratory fatigue tests[1] of notched specimens, and has been plotted in terms of the ultimate tensile strength of the bolt and the endurance limit of the bolt for completely reversed cycles of stress. For example, if the mean load on the bolt were 0.4 of

[1] See, for instance: "The Effect of Range of Stress on the Fatigue Strength of Metals," J. O. Smith, Engineering Experiment Station, University of Illinois, Urbana, Ill., Bulletin No. 334, 1941.

its static ultimate strength, the ordinate to point *A* indicates that the bolt would fail by fatigue if the alternating load ($F_b/2$) on the bolt exceeded 0.6 of the endurance limit for completely reversed cycles of stress. Thus the alternating load which the bolt will withstand without fracture, decreases in direct proportion as the mean stress in the bolt is increased.

Under repeated loading the increased thread pressures on the first few threads of the nut and the sharp notches at the roots of the threads develop high localized stresses that are the significant stresses that measure the extent to which the bolt may be loaded without failure. The significant localized stresses may be as much as 2 to 4 times the stress computed by dividing the fluctuating load by the area of the bolt. Therefore, the endurance limit for completely reversed stress on which the ordinates for Fig. 9 are based is not that obtained from tests of polished specimens of the material, but should be the endurance limit of the bolt including the reduction of fatigue strength caused by these localized stresses. If reliable values for this fatigue strength are not available, a rough estimate could be obtained by dividing the fatigue strength of polished specimens of the material by an appropriate stress-concentration factor to account for the reduction in strength caused by the "stress raisers."

If trouble with fatigue failure of bolts in service is experienced, the results in Fig. 3 indicate that the alternating load (and consequently the significant stresses) in the bolt could be reduced somewhat by decreasing the relative stiffness of the bolt. The relative stiffness (k_2/k_1) may be decreased by (1) reducing the diameter of the shank of the bolt to a value slightly below the root diameter of the screw threads; (2) increasing the length of the bolt; (3) using nuts of a metal having a low modulus of elasticity; or (4) adding washers of relatively low modulus.

SUMMARY AND CONCLUSIONS

The relationships thus considered indicate that in general the designer or the user of bolted joints is confronted with two opposing factors: (1) the initial bolt tension must be set sufficiently high to obtain a good factor of safety against opening of the joint; (2) the bolt tension must be kept as low as possible so that the bolt will carry the service loads without yielding and can withstand the fluctuations of load without developing a fatigue fracture. However, since the stiffness of most bolts is small compared with that of the members joined, the alternating loads carried by the bolt are small. It is probable that few bolts would fracture in service if the loads were truly axial, and the bolt tension just sufficient to prevent opening of the joint.

Excessively high initial bolt tensions are to be avoided since they may result in localized yielding of the bolt in service. On the other hand there is a definite tendency for all localized bearing surfaces on threads, nuts, surface imperfections, etc., to wear in slightly during the first few cycles of operation and this wear is cumulative in causing the mean bolt tension to drop. If the decrease in bolt tension is sufficient to allow the joint to open slightly the bolt must then carry the full external repeated load, and as a result an early fatigue failure of the bolt occurs.

For a critical member in a machine a careful study of the maximum load and of the fluctuating loads carried by the bolts should be made and a factor of safety employed which is sufficient to take care of unavoidable variations in initial bolt tension, imperfections in mechanical fit of the members, and eccentricity of loading of the bolt.

Many of the failures that have occurred in bolts in service may be attributed to bending or shearing forces on the bolt. It should be emphasized that the deformations occurring in most bolted assemblies tend to produce some bending of the bolt, which may in some cases be the primary cause of failure. A further study of the added bending stresses is therefore necessary before a complete analysis of the bolt stresses is available.

Men and Machines

(Continued from page 587)

save humanity. He will lead humanity to happier, nobler, and freer lives by his conquest over nature. He will open up a realm of peaceful living as yet undreamt of. But he will not control the world. He will not mechanize the human soul. He will realize that there is more to life than creature comforts, that man is ever striving toward the Infinite, toward a higher goal than the mere satisfaction of his bodily desires. We need a new balance of values, a new order of ideals, a new standard of happiness. We shall never rest content until the whole world can enjoy this new balance of values, this new order of ideals, this new standard of happiness, and in building up the new world, the engineer will always play a great and noble part. His motto will be

"Keep ye the law—
  be swift in all obedience—
Clear the land of evil,
  drive the road and bridge the ford.
Make ye sure to each his own
  that he reap where he hath sown;
By the peace among Our peoples
  let men know we serve the Lord!"

It is for that we are fighting; not for glory, not for wealth, not for power—but for peace among the peoples. In the calm certainty that our cause is just, we shall press ardently forward toward our goal. The path is dark and toilsome. Like Christian in "Pilgrim's Progress," we have escaped from Castle Doubting. We have vanquished Giant Despair. We may yet have to pass through the Valley of the Shadow of Death. But already I see the dawn breaking over the Delectable Mountains. I see Victory—I see Peace among the peoples of the whole earth.

Industrial Trucks

(Continued from page 588)

quired in these compounds, these materials are not longer available and probably will not be supplied for the duration of the war.

The tire companies have now standardized on a material which consumes approximately 20 to 30 per cent more power for a given truck, measured in watthours per ton-mile. A harder compound that was formerly available had somewhat longer life and was better able to withstand overloads but this material ran from 60 to 100 per cent more power per ton-mile than the best of the earlier electric compounds.

Pneumatic tires are not available on the usual types of industrial trucks due to their inability to carry the necessary loads and still confine themselves to the small diameters and narrow widths necessary on trucks of this type operating in congested places.

Steel tires which have proved to be impractical on electrically propelled vehicles, due to the stresses produced in the truck itself as well as the damage to flooring, are used quite widely on hand-lift trucks. This is permissible because of the relatively slow speed of hand equipment, as well as the lighter loading of the truck itself. On steel wheels, the running friction is lighter than that of rubber although it would be found to require considerably heavier pull in starting when the truck rests in a crack in the floor. The steel wheels are more sensitive to general floor roughness or floor softness than is the case with rubber, because of the high concentrated pressures on the floor surface.

HORSEPOWER *of* HYDRAULIC-TURBINE WHEELS

By FRED L. B. MILLER

PORTLAND, OREGON

DURING a recent investigation of possible power development in the Northwest, it was found that sizes for turbine wheel shafting were limited because of the utilization of machine and transportation facilities for defense work. Because of this situation it was necessary to base the power computations on the maximum size of shafting available and to keep the wheel horsepower within the proper limit. The allowable unit torsional stress was determined, assuming pure torsion, from information on the turbines at Grand Coulee Dam, the stress being 450 psi. An interesting part of this problem occurred in the determination of an expression for the specific speed in terms of the head of water.

A revised curve of specific speed versus head for a Francis type wheel was plotted on logarithmic co-ordinates, and the equation found to be

$$N_s = \sqrt{\frac{330{,}000}{h}} \quad \ldots[1]$$

where
N_s = specific speed, rpm
h = head, ft

This expression was then substituted for N_s in the equation

$$N_s = \frac{N\sqrt{p}}{h^{5/4}}$$

where
N = speed, rpm
p = horsepower, giving the expression

$$330{,}000 = \frac{N^2 p}{h^{5/2}} \quad \ldots[2]$$

By combining expressions for the horsepower and torsional stress

namely $p = \dfrac{T 2\pi N}{33{,}000}$
where T = torque, lb-ft, and
$S = 192\, T/\pi D^3$
where D = shaft diam, in.
S = torsional stress, psi

the following expression is obtained

$$S = \frac{26{,}700\, p}{D^3 N} \quad \ldots[3]$$

$$S = 450 \text{ psi};\ D^3 = \frac{59.5\, p}{N} \quad \ldots[4]$$

Solving Equation [4] for p and substituting in Equation [2]

$$D = \sqrt[3]{\frac{19{,}700{,}000\, h^{5/2}}{N^3}} \quad \ldots\ldots\ldots\ldots[5]$$

By making use of Equations [4] and [5], the accompanying chart was plotted.

Finally, expressions for the speed and horsepower are given thus

$$N = \sqrt[3]{\frac{19{,}700{,}000\, h^{5/2}}{D^3}} \quad \ldots\ldots\ldots\ldots[6]$$

and

$$p = D^2 \sqrt[3]{93.25\, h^{5/2}} \quad \ldots\ldots\ldots\ldots[7]$$

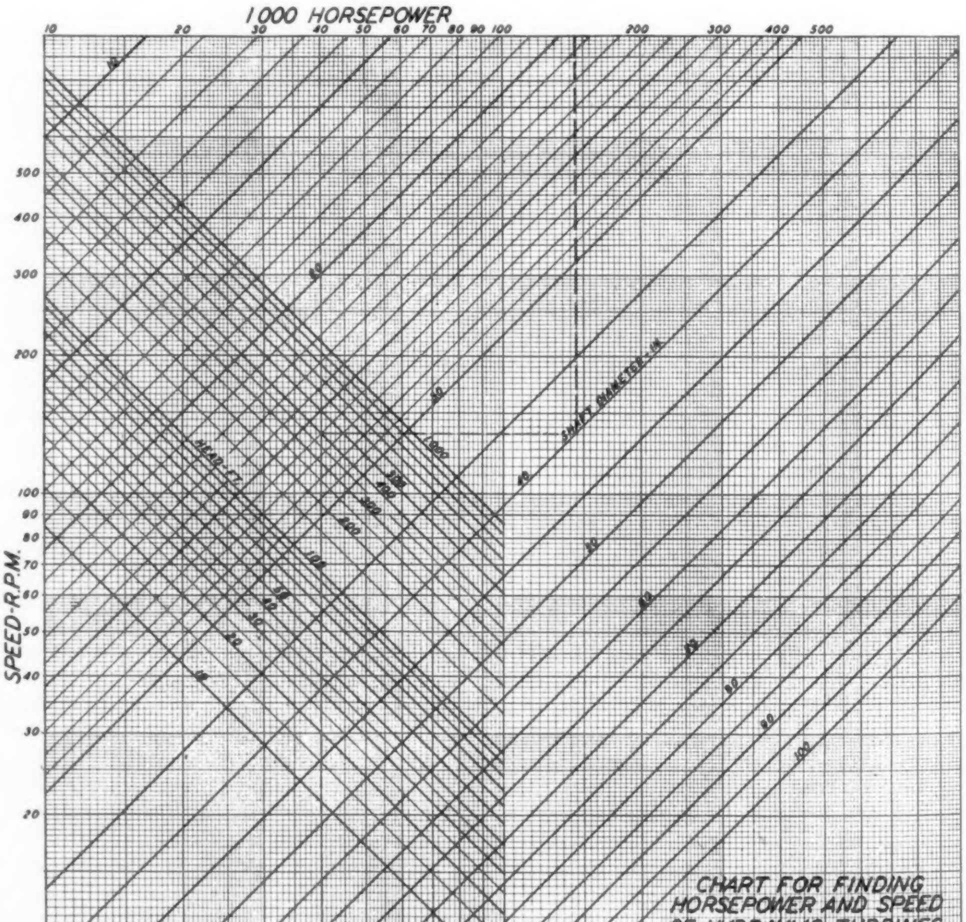
To find the horsepower without reference to speed N, enter the chart at the bottom left, shaft diameter, in., and pass vertically to the proper diagonal marked head, ft, proceed horizontally to the diagonal marked "shaft diameter, in.," then vertically and read horsepower. See the example in dotted line.

To find the speed, begin as before but pass horizontally to the left from the diagonal marked head, ft, and read speed, rpm.

For an example, take any recently designed turbines such as those at Coulee Dam.

Shaft diameter = 42 in. Speed = 120 rpm Head = 335 ft

Starting at bottom left of chart, 42 in., pass vertically to head = 335 ft, read speed = 120 rpm to the left, pass horizontally to shaft diameter = 42 in., then vertically and read horsepower = 150,000, which is the rated horsepower for the large units in the Grand Coulee powerhouse.



INDUSTRIAL STATISTICS[1]

By GEORGE P. WADSWORTH

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

ONLY within the last few years have the significance and value of statistical methods become apparent to American producers. This development is attributable primarily to the work of Walter A. Shewhart in the field of quality control. More recently methods developed by R. A. Fisher have found their place in the development and quality-control divisions of many large plants. The new techniques resulting from the efforts of these pioneers have wide and important applications at the present time. The industrial speed-up program and the pressure to produce high-grade output at a mass-production rate make it essential that careful study of inspection methods be undertaken. Sources of harmful variation in production must be located and remedied with a minimum amount of time and experimentation. This can be accomplished in most cases only by a statistical study of the variation of production and then by the use of statistical techniques to determine whether or not day-by-day variations are significantly different from the standard quality. Particularly in development work, where desirable changes must be determined rapidly and with a minimum amount of experimental data, statistical techniques are essential.

Because of the importance of handling these general problems of quality control and designed experimentation for industry, the statistical methods available in the literature as applied to biological and other scientific data have been re-examined for possible industrial applications. Since the statisticians at M.I.T. have for some time been investigating the possibility of applying statistical methods to industry, Professor Freeman of the Economics Department of the Institute is well qualified to sift out and discuss those methods which are applicable to the needs of manufacturing concerns.

His new book[2] is written for engineers and scientists and can easily be understood and applied by one who has had no previous statistical training. Not only is its emphasis upon the practical use of statistical methods as applied to industrial and engineering problems, but also it has the added advantage that the assumptions and hypotheses underlying the formulas are clearly explained. This leaves the reader in no doubt as to the problems to which statistical methods can be applied and aids materially in preventing the application of the methods to problems for which the methods are inappropriate. This feature makes it possible for the reader to understand many of the assumptions that lie behind the derivation of formulas without having a more advanced knowledge of mathematical techniques.

The statistician finds it easier to apply with assurance a statistical method to a given set of data if he has available some examples of actual industrial problems. He may then consider the assumptions that were laid down in the examples and see whether or not his new problem comes under the same category. In connection with all the techniques described in this book, such examples are worked out. Since statistical methods are based upon the laws of probability, an answer in the form of a probability is the solution of most industrial problems. To enable the nonmathematician to understand these solutions, carefully prepared diagrams and charts have been used with shaded areas illustrating the significant points.

The book deals with two types of problems of utmost importance to industrial engineers, scientists, development engineers, and research workers. (1) The arrangement, analysis, and significance of experimental data already obtained in previous work and as yet in such form that the maximum amount of information has not been obtained. (2) The available methods and schemes which can be used to outline and perform experiments in order to maximize the information and minimize the number of experimental observations that must be made.

The first form of analysis is one which has been considered at great length for a long time and has been successfully applied to industrial data. But the question of design of experiments is one on which the industrial statistician has not until recently spent much time and thought and is generally not treated so thoroughly in an elementary textbook on this subject. The idea of carrying out small-scale experimentation right on the production line in order to obtain a large amount of valuable information is a really new idea. As applied to the design of experiments for development work, this method in many cases greatly reduces the time necessary to carry out experiments for the purpose of obtaining or verifying essential information.

Analysis of variability is handled in an especially effective manner in that it is treated continuously throughout the book in connection with each subject discussed. In most textbooks analysis of variance is considered separately and this procedure makes the tie-up with other statistical methods rather obscure. Professor Freeman's treatment brings out the significance of differences of several averages, regressions, correlation studies, and covariance by clearly indicating their important interrelationships. This certainly is one of the distinguishing features of the book.

The author at the beginning takes up the general question of sample theory from the small-sample viewpoint—a method of approach which makes the book immediately useful in the first few pages for industrial and experimental work. Large-sample theory is included, of course, but as a limit of the small-sample theory rather than as a separate entity. The first three chapters deal with such questions as significance of differences between two and several means, tests for determining whether or not two variances are likely to be different, practical considerations involved in testing data by one hypothesis as compared with another, tests for normality, designed experiments, and analysis and relationships between variables. The several types of regression are discussed and also the question of breaking up total variability into its component parts in order that they may be allocated to specific causes. Knowledge of how this breakup should be effected in specific cases and of the nature of the hypotheses being tested is, of course, essential if complicated cases of analysis of variance are to be correctly handled. To interpret the different interactions and to appraise the value of primary variability are necessary to the successful application of these methods to industrial data. These first three chapters are well integrated and the relationships between individual techniques are carefully explained.

The last two chapters are devoted to the discussion and

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Industrial Statistics," by H. A. Freeman, John Wiley & Sons Inc., New York, N. Y., 1942, 178 pages.

application of systematic quality-control methods and their relationship to consumer and producer risks. This type of work has been used by industrialists in this country for quite a few years and is now attracting a great deal of attention. The book considers actual problems which have arisen on the production line and indicates what happens under control and noncontrol of output. It also deals with the setting up of a systematic method of quality control and with the limitations and difficulties one may run into in the actual operation of such methods. Two important types of cases are considered. First, there are the cases in which the variables being considered as a measure of quality of output are actually being evaluated as continuous variables, and second, there are those cases in which the only information available is that concerning the fraction defective. In these chapters Professor Freeman introduces enough data to illustrate the setting up of a control system on a particular item, and he also makes clear how the system may be extended to an entire plant that is organized with a specific scheme of quality control of output and of intermediary processes. Here are considered the probable risks which producers and buyers undergo when they sample and test portions of a product to be purchased or sold. This involves the question of how large a sample should be taken in order to assure a certain risk that the entire lot shall meet the specifications, and also the question of what the specifications should be for both the producer and the buyer as far as tolerance limits and the size of the sample are concerned. The author points out that producers and buyers should settle on some scheme of sampling between themselves, and he shows what the tolerance limits should be in order that the parties should experience specific predetermined risks and thus be certain that they are buying and selling a product of the desired quality.

At the end of each of the chapters there is a series of notes on the mathematical phases of the subject which are pertinent to the material dealt with in the text. At the end of the first chapter is a discussion of tests for normality, moments, properties of the normal distribution, distribution of statistics resulting from sampling from a normal distribution, normality of the distribution of means, and the normality of the differences between two means. Also included are estimates of the standard deviation and a treatment of the nature of certain statistics, such as the Fisher "t." At the end of the second chapter the author considers more completely what happens algebraically in the analysis of variance, the distributions of F and X^2, the estimation of variance, and unbiased estimations of the population standard deviation resulting from a general analysis of variance. In the notes at the end of chapters four and five the distributions involved in the fraction defective are considered, and there is also a brief discussion of the distribution of the coefficient of variation. At the end of the book is a fine selection of useful tables, especially tables involving the distribution of statistics for the testing of normality and the L_0 and L_1 tables. These tables facilitate the solution of a large number of industrial problems without the necessity of searching elsewhere for the level of significance of distributions which occur frequently.

INDUSTRIAL MAGNETISM

(Cleaning a magnetic chuck on one of the grinders, one of 519 machine tools, in the new $26,000,000 plant of the Merchant Marine Division of the Westinghouse Company dedicated on May 22 and actively engaged in turning out propulsion turbines and reduction gears for the U. S. Maritime Commission's vessels. Steel erection for the plant, which has 615,000 sq ft of floor area, was started on Nov. 11, 1941, and actual production began on Jan. 16, 1942.)

THE ARMY SPECIALIST CORPS

By WILLIAM O. HOTCHKISS

DEPUTY DIRECTOR

RECENTLY I heard an experienced Army officer state emphatically that "our most valuable asset is man power." I agreed with him heartily and added that that part of our man power with highly trained brain power was the most precious of all. We have read frequently of "bottlenecks" in the supply of steel plates for ships, or of engines for airplanes, or of tanks and guns. We have rarely or never seen in print the real "bottleneck," which was that there were not enough men with the proper quantity and quality of brain power working on the problem in time. Every instance of "too little and too late" in ships, in supplies, and munitions can be stated in terms of too little and too late application of trained brains to the problem.

For many lines of activity necessary for war purposes there are not in existence a sufficient number of properly trained and skilled individuals. We have priorities on most kinds of materials, but we have not yet heard of any really adequate plan for priorities for our trained brain power. We have not yet developed a workable scheme to stop this waste. The matter is complex and involved but nevertheless we must stop in every way we can the waste of the most precious part of our most valuable asset—trained man power. I know of no more effective way to aid our enemies, the Germans and the Japs, than to permit in any way such waste. The man who sees it and does not strive to prevent it is guilty of some degree of "contributory treason" whether that be recognized as a crime or not.

NUMBER OF TRAINED OFFICERS SMALL

In the conduct of war there is as wide a diversity of occupations as there is in civil life, plus a wide range of duties that are not present in civil life. All these activities have one single aim and objective, the successful engagement of the enemy in combat. Everything is pointed toward the day when we go into the fight and win. To accomplish this objective all of the preparatory duties of all kinds must be well done. But no matter how perfectly the preparatory duties are done the battle will not be surely won unless the officers in command can operate our troops better than the enemy officers operate theirs, other things being equal. Obviously the highest professional military skill is necessary for this. Someone has said that a good general is as valuable as an extra army. I think I should state it by paraphrasing the familiar old definition of an engineer: "A good general is one who can do with one division the things an ordinary general can do with two."

One of the serious bottlenecks in this war is our supply of officers with professional military training and experience. We cannot afford to waste a single one on duties of any other nature. Always in peacetime we have maintained an army of relatively insignificant numbers. When war comes upon us it is not only a scramble to build the ships and planes and tanks and guns needed, it is a scramble to give anything like adequate professional military training to the great numbers of new officers the rapid expansion of the army demands. To waste this particularly valuable trained skill in any way is again in some degree "contributory treason." There is no more effective way to help our enemies.

The transition from an army of 150,000 officers and men which we had just a few years ago to an army numbered in millions is really a catastrophe. It upsets everything both in personal lives and in business affairs. In a modern war few persons escape its effects. War is no longer the affair of armies, it is the affair of the whole population of nations. Every man, woman, and child; every pound of steel, aluminum, and tin is a factor in and affected by this transition to total war. Every energy, every material, every mental resource we have must be used with the greatest possible speed and with the utmost practical efficiency if we are to be sure to win this war.

The highest function of a military officer is the effective use of his knowledge of strategy and the use of troops and equipment in contact with the enemy. There are multitudinous other functions which are vital adjuncts to these professional military functions. These adjunct functions, in many instances, can be satisfactorily performed by men who have gained the proper experience in their civil occupations. An army is like a great city. Its men must be housed and clothed. They must be fed and provided with necessary utilities, heat, water, light, and sanitary and hospital facilities. They require huge transportation facilities that must operate without fail under difficult and dangerous conditions. They require innumerable repair-shop units to keep their equipment in good operating condition. Roads and railroads must be built and bridges repaired or erected with great speed. All the vast quantities of supplies of clothing, food, shelter, vehicles, arms, tanks, planes, munitions must be contracted for, received and warehoused, paid for, shipped by rail, truck, plane, and by ship, and again from the unloading port by rail, truck, or plane. The Army must be paid. A vast accounting job must be performed.

TO PERFORM NONCOMBATANT DUTIES

These adjunct duties are very closely parallel to the duties that must be performed in civil life. They can be performed by men who are not professional military men. Capable engineers and businessmen of many different kinds can be used to carry on much of this work, but they must do it as officers under military command and with military responsibility, not as civilian employees who can quit the job whenever they desire.

With such considerations in mind General George C. Marshall, Chief of Staff, suggested to the Secretary of War the establishment of the Army Specialist Corps. One of the chief objectives was to enable our Army to make the most efficient use possible of the professional military training and talent available.

An erroneous impression has gained credence that only men who are beyond military age, or who are physically disqualified for military service, will be appointed as officers in the Army Specialist Corps. Such is not the case. This is only one of the purposes of the establishment of the Corps. A more important purpose is to secure officers, who, though they lack the experience and training to command troops, can perform vitally important noncombatant military services along the lines of their civilian business and technical experience. It is very likely that thousands of Army Specialist Corps officers will serve with active units of the fighting forces, in the air and on the ground. They can aid in transporting supplies and

An address presented at the Annual Meeting, New York, N. Y., June 27–29, 1942, of the Society for the Promotion of Engineering Education.

munitions. They can aid in operating the new technical equipment for air operations. They can carry on business and financial duties. They will help conduct the multifarious business of feeding, clothing, housing, equipping, and supplying the armed forces. They will aid in repairing damaged equipment and in many activities that will use fully the knowledge of engineering, science, business, and financial matters they acquired as civilians. Many of these men will be of military age and most of them serving with combat units must be as physically fit as troop officers.

In addition to officers of military age and physical fitness the Army Specialist Corps will appoint many officers from the group of overage and physically disqualified men. Men who for these reasons cannot perform arduous work can be used for work similar in physical requirements to what they are now doing as civilians. In these cases the age and physical condition demanded will be only that necessary for the less arduous work they will be called on to do. In the selection of such officers emphasis will be placed on their having the brains and mental ability necessary for the job rather than on their physical condition.

Quite naturally the greatest use for Army Specialist Corps officers is likely to be in the Services of Supply. This is a great procurement and transportation and technical group of activities where men qualified by civilian experience can be most quickly and readily put to work. Procurement objectives for many of the services have already been authorized, under which they are now preparing the definite requisitions for the appointment of Army Specialist Corps officers. As an illustration of the diversity of occupations to be served the following partial list is given:

Transportation Division	Statistical Service
Corps of Engineers	Special Service
Signal Corps	General Depots Division
Quartermaster Corps	Provost Marshal General
Chemical Warfare Service	Judge Advocate General
Ordnance Department	Public Relations
Post Exchange Services	Military Intelligence

In addition to serving the organizations in the Services of Supply, Army Specialist Corps officers will be of use in the Ground Forces and in the Air Forces. They can serve as special service officers, supply officers, executives, engineer officers, research officers, statisticians, quartermaster officers, personnel officers, ordnance officers, public-relations officers, communication officers, post exchange officers, finance and budget officers, and in many other fields. Many technical positions in motorized and air units can be filled by Army Specialist Corps appointees.

Out of the statements preceding it may be well to summarize the main purposes of the Army Specialist Corps. One of the principal functions is to find, appoint, and assign to the requisitioning branch, men properly qualified by civilian experience to perform noncombatant military duties that would otherwise have to be performed by professional military officers of the Army of the United States. A second principal function is to help in the more complete use of man power by using the services of men disqualified for arduous military duty by reason of age or partial physical disability. Many of these disqualified men are daily performing in their civil occupations the same kind of duty that the Army needs. In appointing such officers the physical qualification required is that they can do the job. Brains and experience are emphasized, and physical vigor is required only sufficient for the duties.

KIND OF MEN WANTED

The kind of men wanted for officers for the Army Specialist Corps is obvious. Men distinctly of officer quality are needed. They must be men of unquestionable loyalty, integrity, of education sufficient for the job, of good teamwork capacity. They must have had experience sufficient to enable them to handle the particular job thay are appointed to fill. For service in Continental United States, only commissioned officers will at present be appointed. For service overseas, both commissioned and noncommissioned officers will be appointed.

Candidates for officers in the Army Specialist Corps will be sought widely over the country. The Adjutant General's Office and the Army Specialist Corps are co-operating in establishing offices in many of the principal cities of the country to secure officers both for the Army of the United States and this Corps.

Corps Area Headquarters of this Corps will be in close co-operation and co-ordination with these offices. These offices will have lists of job specifications for the kind of positions to be filled. Through informed local sources they will seek for men with the proper qualifications willing to offer their services to their country. These procurement offices will be staffed jointly by officers of the Army of the United States and the Army Specialist Corps. It is believed that through these offices men of the finest quality can be brought into the service.

In addition to the men secured by these offices the Corps has access to the questionnaires (applications) now filed in the Adjutant General's Office, the Civil Service Commission, and in the National Roster of Scientific and Specialized Personnel, and many other sources. When these fail to provide a sufficient number of properly qualified officers the Army Specialist Corps is authorized to train men to fill the needs.

It is in this last group that it will be particularly valuable to have the complete co-operation of the engineering colleges of the country. The Army and the Navy have jointly asked you to count your graduates in electrical engineering of the last ten years. They have failed to find in that group a sufficient number of men to train in the ultra-high-frequency courses which you and they are giving. Apparently, it is going to be necessary to lower the sights to secure the numbers that must be trained. It will almost undoubtedly be necessary to ask you to look through your records and circularize *all* engineering graduates of the last ten years and also your students who dropped out before completing their work, men who completed only enough of their courses to have a background of physics and mathematics sufficient to warrant their being given refresher courses followed by the special courses needed to supply the demand. Plans are now being formulated to ask your co-operation in this important project. You will be notified as soon as present preliminary studies are completed.

I want to emphasize here that many engineers under 30 who are in Selective Service Class IV-F will be urgently needed.

Present plans are that these men selected for training will be commissioned, some such as those in Class I-A of the Selective Service in the Army of the United States and others in the Army Specialist Corps. They will then be assigned for training to the various engineering schools and to the schools maintained by the Signal Corps in accordance with their qualifications and the needs of the service. It is hoped that the organization and management of the courses may be handled by the United States Office of Education under the National Advisory Committee for Engineering, Science, and Management Defense Training as their courses are now being given. In this way existing facilities will be most efficiently used and duplication of teaching personnel, equipment, and expense eliminated.

Men eligible for appointment in the Army Specialist Corps are limited by the recent order of the Secretary of War. This provides that officers may *not* be commissioned in the Corps who are

(*a*) In the 20–30 age group unless in Class IV-F, "permanently physically disqualified for general military service"
(*b*) In the 30–45 age group if in Class I-A of the Selective Service
(*c*) Deferred from induction for occupational reasons unless the Selective Service agrees that they may be taken into the Army Specialist Corps.

Exceptions may be made in cases where the candidate has qualifications specially needed. In this connection it is well to remember that regulations and orders may be altered from time to time as conditions require. It is not improbable that for the urgent needs of the Signal Corps restriction "*a*" in the preceding paragraph may have to be modified to make men of the 20–30 age group in Selective Service Classes I-B and III-A eligible for appointment in the Corps.

The Army Specialist Corps does not compete with the Selective Service. Men deferred for occupational reasons are not eligible. It is just as necessary to have these men producing war materials as it is to have men in the combat units to use them. Officers appointed to the Corps are not thereby taken out of the jurisdiction of the Selective Service according to law. They may be recalled by their draft boards and inducted. But, of course, it is unlikely that Corps officers serving overseas with troops will be brought home for induction. Overseas Corps officers should be credited to the quota of their draft board the same as men in the Army. While this is not now possible it may become so as the needs become more apparent. Furthermore, since no officers will be appointed from Class I-A, it is very improbable that many Army Specialist Corps officers will be called by their draft boards.

PROCEDURE FOR MAKING APPOINTMENTS

You will be interested in the procedure necessary for appointment of officers in the Army Specialist Corps. It is practically the same as for officers in the Army of the United States. It is set down here in chronological order.

1 The arm or service needing Army Specialist Corps officers files an approved procurement objective, which is its estimate of the total number of officers to be appointed.

2 Under this it files requisitions stating the kind of jobs to be done, the various ranks desired, the time the officers will be needed, and where and to whom they are to report.

3 Requisitions are distributed to the joint procurement offices over the country, and search is also made in the files of the Adjutant General's Office and elsewhere for qualified men.

4 Questionnaires, Form 0850, are studied, compared, and records of suitable candidates are submitted to the requisitioning agency for their final approval, after personal interviews with the candidates if they so wish.

5 After this selection the files are sent to the War Department Personnel Board which acts for the Secretary of War in approval or disapproval of the appointment.

6 On return of the files of approved candidates they are sent to the Adjutant General's Office for issuance of the appointment, for securing the oath of office, and for issuance of orders as to when and where to report.

7 Appointment of officers of the rank of major[1] and above must go through an additional procedure in "6" above. After approval by the War Department Personnel Board these officers' names must go to the Secretary of War and to the President who must nominate them to the Senate for its approval, which must be forthcoming before the commission and orders can be issued.

[1] Recent legislation changed this from "major" to "lieutenant colonel."

CORPS WILL NOT MAINTAIN OPERATING FORCE

The Army Specialist Corps will not maintain any operating force other than its headquarters and field procurement staff. All other officers appointed will be immediately assigned to the arm or service that requisitioned them. Thereafter they will be under the orders of that branch. Judging from the inquiries I receive there is a general misconception of this matter. Many persons seem to think that the Army Specialist Corps will operate groups of specialists under its own command to serve the armed forces in special technical and scientific fields. Such is not the case. All activities of Specialist Corps officers other than its own staff will be directly under the command of the various branches of the Army to which they are assigned.

From this picture I have given you of the functions of the Army Specialist Corps it is obvious that the Corps will afford an opportunity for service to many fine, loyal, patriotic citizens who have hitherto been barred for various reasons. Some have obligations to dependents which could not be met if they volunteered. This Corps will provide an opportunity for many to secure such a commission that will enable them to care for these obligations. Others denied commissions in the regular army by reason of age or disability will be usable by the Corps. Many in all these groups will find in the Corps a very welcome opportunity for them to render the service their patriotism is seeking. The Corps will be composed of men of outstanding ability and character. Every man in it will be serving because of his patriotic desire to do his bit for his country in its time of need.

Magnesium Fires

A NEW and more effective method of extinguishing magnesium fires has been developed by the Bureau of Mines according to an article in *Safety Engineering* for February, 1942.

Designed for places where magnesium is handled continuously, the method is equally effective for incendiary bombs of the magnesium type. According to the Bureau report, hard coal-tar pitch in granulated or flaked form (do not use it in the powdered form) is a highly satisfactory substance for extinguishing a magnesium flame. When spread upon a magnesium incendiary bomb or a small magnesium fire, the coal-tar pitch softens and forms an air-tight blanket which quickly smothers the flame.

To extinguish a bomb on a wood floor such as an attic, cover the bomb with a layer of pitch to stop the heat and glare. Then spread a layer of pitch on the floor nearby, roll the bomb with a long-handled shovel or hoe onto this layer, and cover the entire mass with more pitch. This is necessary because the burning bomb can get air through the pores and cracks of the wood floor. A bomb rolled in pitch this way is completely extinguished and does not have to be removed from the building immediately. After the pitch has cooled sufficiently to handle, it can be moved simply by rolling it up like a carpet.

Because some incendiary bombs contain mild explosive charges which hurl small fragments, the Bureau recommends that protective clothing and goggles be worn and that long-handled implements be used in dealing with a magnesinm bomb.

The proper procedures for dealing with incendiary bombs and extinguishing small magnesium fires on various surfaces are described in an abstract of Report of Investigations entitled, "Methods of Extinguishing Fires and Incendiary Bombs With Very Hard Coal-Tar Pitch," by H. R. Brown, Irving Hartmann, and John Nagy. Copies of the abstract may be obtained from the Bureau of Mines, Department of the Interior, Washington, D. C.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Modern Elevator Practice

Comment by S. F. Davies[1]

In this interesting paper,[2] the author has clearly outlined the most important items which engage the attention of elevator manufacturers, architects, and engineers.

While the danger of overtravel of the car or counterweight of a traction-type elevator is overcome in most installations when the car or weight rests on the bottom of the shaft, as the author states, that is not the case where the car travel is unusually high.

The dead weight of the long hoist ropes on the "down" side is enough to hold the traction of the ropes on the driving sheave and permit the car or weight to go into the overhead on complete failure of the electric stopping devices.

The author's suggestion that the 6 × 19 and the 8 × 19 construction for elevator hoist ropes will answer all elevator requirements is agreed with. Two types of hoist ropes will still require a great amount of research to enable the manufacturers to arrive at conclusions which will permit them to make recommendations that will show consistent performance.

The author has called attention to the need for understanding and care in the design and application of the car safety device for use on elevator cars operating at the higher speeds. As he states, it is very important that the time between the start of governor operation and the instant the safety jaws begin to grip the guide rails be reduced to the lowest possible minimum. It is also important that the governor be so designed that it will not permit the "backlash" of the governor rope to release the governor rope-gripping jaws.

The modern type of elevator mechanical and electrical interlock is a great improvement over the old style "contact and lock," but still is not foolproof. It does not protect the person who is authorized to use the hatchway-door-opening key.

In recent years a number of fatal and near-fatal accidents have occurred when a mechanic, porter, operator, or starter has used the hatchway-door key to open a door and, expecting the car to be at the floor, has stepped into the open hatchway. In the writer's opinion, the hatchway doors should be provided with a device (if practical as part of the interlock) which will permit the hatchway door to open only 6 or 8 in., when first released by the key and the car is not at the floor. The sudden stopping of the panels after that short travel will indicate to the person opening the door that the car is away from the floor. The device can be designed to permit full opening of the panels, after the initial stop when it is necessary.

[1] Kaiser, Muller & Davies, Consulting Engineers, New York, N. Y.

[2] "Modern Elevator Practice," by E. M. Bouton, Mechanical Engineering, March, 1942, pp. 193–200.

Comment by J. A. Dickinson[3]

The author states that until the development of the electric elevator, the hydraulic-plunger elevator was the accepted standard.

Many of the high-speed hydraulics installed in the 90's were of the rope-geared type rather than the plunger type. Speeds of 600 fpm or higher were frequently obtained and, in at least one installation, down speeds in excess of 1000 fpm were recorded.

Overbalance of Counterweight. The statement is made that the counterweight is equal to the weight of the car plus approximately 40 per cent of the capacity load. It may be shown that the most economical balance is one half of the average load to be handled by the car. In the case of the Washington Monument, where loads of approximately 90 per cent of the contract capacity of 6000 lb are the rule, counterweighting was made 45 per cent. In other cases, such as stretcher lifts in hospitals, where the average load will be only a small percentage of the contract load, counterweighting as low as 25 or 30 per cent may be indicated.

In discussing ropings, the statement is made that, with 2-to-1 roping, the car velocity is one half that of the periphery of the driving sheave. This is of course not literally true unless the periphery happens to coincide with the rope axis. This condition can probably be made somewhat clearer by saying that the car velocity is one half the rope velocity.

Rope Construction. The author suggests that probably two rope constructions would meet practically all requirements for elevator service. The two shown are a 6 × 19 filler-wire and an 8 × 19 Seale patent construction. A number of manufacturers use the Seale construction in the 6 × 19 and, where reasonably large ratios of rope diameter to sheave diameter can be used, will probably give somewhat longer life than the 6 × 19 filler-wire. The Seale construction has only 9 surface wires per strand, whereas the filler-wire construction has 12 wires per strand. These smaller wires wear relatively faster than the larger wires on the Seale construction, although they do provide a somewhat more flexible rope.

Hydraulic Oil Buffers. In discussing hydraulic oil buffers the statement is made by the author that a plunger forces oil through orifices which become smaller as the buffer is forced down. There are, in general, two distinct types of buffer porting; one in which a number of holes of uniform size are successively cut off by the piston, and the other in which the piston serves to decrease the area of an opening available for vertical flow. Both have advantages and disadvantages, and successful buffers have been designed using both systems.

Elevator Car. It is unfortunate that the author did not mention roller guides. While these guides have come into use only recently, they do provide a smoother operation than would be possible with solid-metal shoes, and apparently they effect marked economy in operating current. The assembly consists of three rollers, one operating on the head of the rail, the other two on the sides of the rail. The arms on which these rollers are mounted are backed with spiral springs and a positive stop is provided to prevent too great an overtravel of the roller assembly. The life of the solid rubber tires used is as great or greater than that of a set of hoisting cables.

Systems of Operation. The "signal-control elevator" is described. It is

[3] Secretary, Sectional Committee for the Elevator Safety Code, Chief of Section of Safety Codes, U. S. Department of Commerce, National Bureau of Standards, Washington, D. C.

rather unfortunate that the word "control" has come into the picture for a type of operation. The various systems of control were very thoroughly covered in the paper and were properly classified. The elevator code defines "Signal-operation elevator." The use of the term "signal control," however, predates the definition in the safety code and, for commercial reasons, has been carried over.

One of the principal factors in the development of signal operation has been the fact that at speeds between 700 and 800 fpm, the operator can no longer see the designating number on the hoistway wall. Even if such numbers could be seen, the split-second timing necessary to release the car switch for a given landing would make accurate stops almost impossible from high speeds. Like the stopping distance discussed under action of the safety, the stopping distance under normal machine braking is a function of the square of the speed, and consequently for very high speeds the car stop must be initiated several floors away from the desired landing. With signal operation, such shutoff points can be accurately determined by mechanical or electrical means and accurate stops successfully made from very high speeds.

In the discussion of signal-control elevators the author refers to the system as "full-automatic" operation. This is rather unfortunate in that automatic operation, as defined in the American Standard Elevator Safety Code, describes the operation of an elevator which may be started from a hoistway landing button. Signal operation, on the contrary, does not permit this to be done. The starting of the car is at all times under control of the operator, although a waiting passenger may stop the car going in the direction in which he desires to travel. In many jurisdictions, elevator inspectors have attempted to classify signal operation as "full-automatic," thus requiring certain additional apparatus, such as retiring cam interlocks, which are not necessary in the case of signal operation.

Car Speed. In conclusion, perhaps one other point might well be mentioned, and that is the effect of car speed on service. To the average person a doubling of the contract speed should result in doubling the service given by an elevator. This unfortunately is far from the truth, for the following reasons: (1) No elevator is actually moving during 50 per cent of the time it is in operation. The time necessary for loading and unloading passengers is the same regardless of the free-running speed of the car. (2) The distance necessary to accelerate and to stop the car from full speed increases as the square of the car speed, so that the net gain is relatively small. It is only where there are long runs without stops (express service to the upper floors of a very tall building) that very high speeds are justified.

One very interesting example, which the author may recall, occurred in Washington several years ago. In a bank of elevators serving 14 landings, it was desired to get the maximum possible service per car within the appropriation available. As these cars were used for single-floor express service during rush hours, the gain in service by jumping the speed from 600 fpm to 800 fpm seemed to offer possibilities. Computations on the basis of data, obtained after exhaustive traffic studies had been made in the building, indicated to the writer that the saving would be only 5.9 per cent. In order to obtain a check on this figure, our data were submitted to one of the author's engineers, who advised us shortly afterward that the increased service, attributable to a speed increase of $33^1/_3$ per cent, would not exceed 6 per cent.

Real increases in service afforded by an elevator must generally be looked for in shortening the period of door operation, carefully synchronizing the leveling and opening of hoistway doors, and in providing rather wide shallow cars with openings of adequate width.

Comment by Bassett Jones[4]

Approximately 90 per cent of all elevator accidents are so-called "landing-door accidents," caused by lack of adequate co-ordination of car and door operation. Hence were landing doors to be made fully safe on all elevators of whatever kind and service, nearly 90 per cent of all elevator accidents would be eliminated. In such case, it seems almost a waste of time to discuss other forms of safety devices, particularly when it appears that no mortal accident to a passenger has occurred on a 1-to-1 traction-type elevator because of failure of any part of the elevator apparatus proper to function since the first one was installed in 1905.

Thus, by providing safe loading doors on a 1-to-1 traction elevator, it would seem that a high degree of elevator safety could be attained.

As a matter of fact, both conditions are attained in the modern signal-control (or rather "signal-operation") elevator. There has not been an accident due to any cause on such an elevator since the first one was installed in the Standard Oil Building in New York.

Another matter the writer would like to mention briefly is that of passenger comfort. After all, passenger comfort determines whether or not people will like to ride and, in the end, whether they will ride in any given elevator. Passenger comfort becomes particularly important in high-rise high-speed elevators—those commonly installed in tall tower-type buildings. Then two problems in human physiology must be solved. These two problems may be posed as the questions: (1) How fast can a passenger be moved through a given change in air pressure without causing discomfort? (2) How much more than his normal weight can the passenger be made to weigh in how short a time without discomfort?

The answer to the first question determines the maximum car speed which should be attained during long express runs. Thus, in the Empire State Building, the express cars to the tower observation platforms (ground to 80th floor, without stop, travel 935.6 ft, 0.998 in. change in static air pressure) cannot operate over 1000 fpm without causing passenger discomfort, particularly on the down motion.

In the Radio City tower where the maximum express run is considerably less, and with it a correspondingly reduced change in air pressure, speeds up to 1400 fpm can be attained without discomfort.

The answer to the second question posed is found in determining the maximum acceleration (and retardation) that can be attained and the time in which such speed can be reached without causing discomfort. The problem relates to the third derivative of distance with respect to time (d^3s/dt^3) or the rate of change in acceleration.[5]

Tests have shown that, with the usual time-velocity characteristic inherent in 1-to-1 traction equipment, generator field control, the maximum acceleration that can be attained without discomfort is 8 fps per sec in approximately $^1/_3$ sec. In other words, the passenger's weight relative to the car platform is increased 25 per cent in this time. Subsequently his weight returns to normal when and as the car attains maximum steady velocity.

These two physiological limitations set the limit of high-speed high-rise elevator practice. Mechanical limitations are far beyond the physiological limits.

[4] New York, N.Y.

[5] "The Time-Velocity Characteristics of the High-Speed Passenger Elevators," by Bassett Jones, *General Electric Review*, Feb., 1924, pp. 111–120.

COMMENT BY D. L. LINDQUIST[6]

It may be appropriate, as a supplement to this valuable paper, to call attention to the instantaneous values of retardation occurring when a car safety is applied, instead of taking account only of the average which has been the common practice up to the present time. Perhaps the best way to demonstrate what actual performance must occur is to give a simple example.

Suppose we have two weights each of W pounds suspended by a weightless rope running over a weightless sheave as illustrated in Fig. 1, and that the motion

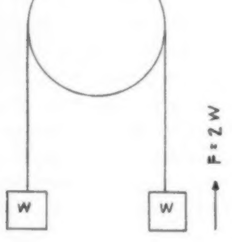


FIG. 1

is in the direction as shown by the arrow. If a constant retarding force (such as a car safety) of $2W$ is suddenly applied to the weight on the right-hand side, then the customary simple way of calculating the resulting retardation is

$$A_1 = \frac{F}{M} = \frac{2W}{2W}g = g$$

This would be correct if the rope had no elasticity. As a matter of fact, however, elevator hoisting ropes are quite elastic and the modulus E may for new ropes be as low as 6×10^6, and for ropes that have been in service a long time but in good condition may exceed 15×10^6. The average may be set at 10.5×10^6. Therefore, when dealing with this problem in reality we cannot very well ignore the elasticity.

If, therefore, the retarding force 2 W were instantly applied to the weight W_2

[6] Chief Engineer, Otis Elevator Company, New York, N. Y. Mem. A.S.M.E.

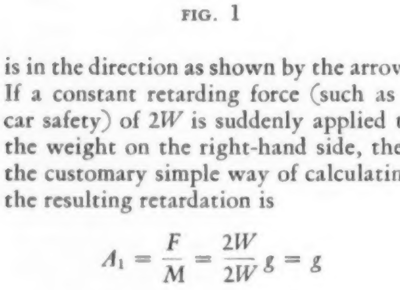


FIG. 2

the calculated performance would be as shown in Fig. 2.

These calculations are based on the condition that the total rope length is such that for a tension of W lb the elongation is 7.5 in. and that the mechanical hysteresis of the rope is 40 per cent with an assumed shape of the hysteresis loop that is reasonably accurate.

At time t_1 both retardations A and A_2 have reached the same value g and from there on both are subject to this constant retardation.

W_2 comes to a stop at time t_2 and W_1 stops at time t_3.

It may be mentioned that for elevators with compensating ropes and "tie-down" tension weight (mono mass safety) both velocity and retarding functions are of undulating nature.

The writer believes it might prove somewhat embarrassing to find that under the conditions assumed, the maximum retardation is 2_g or double that generally assumed. Attention is also called to the fact that when W_2 stops, W_1 is ascending with a velocity of 4.7 fps and must therefore "jump" a corresponding gravity distance, after which it falls back and suddenly fetches up on the ropes. This situation becomes more serious the higher the speed and the shorter the ropes.

This also definitely disproves the generally accepted notion that the counterweight will only "jump" when the safety causes greater retardation than gravity as calculated in the customary way, ignoring rope elasticity.

In reality the situation with sliding-type car safeties is not quite so bad, as the safety is not applied with full force instantly and therefore the maximum retardation is appreciably less than double the "nominal."

For a complete elevator the conditions are, of course, more complicated than the simplified case just analyzed and very accurate calculations are not possible, due to lack of accurate data of certain rope characteristics.

This matter has been given a great deal of attention, and much information about rope characteristics has already been obtained, such as elastic modulae under different conditions, preconditioning, damping effects (energy loss) and for low frequencies the actual shape of the hysteresis loop, as well as many other things.

COMMENT BY LAURENCE MEHARG[7]

In the industry with which the writer is connected, the freight elevator is a very important piece of equipment. It is used to transport all manufactured articles to and from the several floors of our warehouses. It is in continuous use throughout the twenty-four hours of the day. To arrive at the platform size, capacity, speed in feet per minute, and control and operation, we make a study of the following items:

1 Average weight of a warehouse truckload of manufactured ware (truck dimensions have been standardized).

2 Number of trucks that can be economically handled on platforms of different sizes.

3 Height of building in stories.

4 Floor heights.

Three years ago we selected two electric freight elevators built by the author's company for one of our plants.

The capacity of each is 8000 lb, speed 100 fpm, and car dimensions 12 ft wide $\times$ 10 ft deep in the clear between gates.

At each floor, 12-ft-wide $\times$ 9-ft-high metal-clad vertical sliding bi-parting doors with heavy-duty electric door operators are provided for openings. The elevator machine is of the worm-gear traction type, located directly over the hatchway, and single-wrap traction 2:1 roping is used.

A two-speed three-phase 60-cycle 440-v, 900–150 rpm, squirrel-cage motor is direct-connected to the worm of the machine.

The control, on the car only, is of the constant-pressure push-button type, with the automatic self-leveling feature.

The electric door operators cause the doors to open automatically as the car is leveling with the floor and, upon depressing the starting button, will cause the doors to close automatically before the car leaves the landing.

A capacitor is connected to the power-feed wiring of each motor for power-factor correction.

The starting is done with the high-speed motor. The low-speed motor is used only for stopping and for automatic leveling. In the transition between the high speed and the low speed, when the high-speed motor is disconnected from the power source, the slow-speed motor will, acting as a generator and thus supplying the braking effect, slow down to landing speed. In the case of these machines, the speed is $16\,^2/_3$ fpm, by reason of the 6-to-1 ratio of the motor speeds.

These elevators have been in continuous use for over 2 years, and it is a pleasure to see the ease with which they are controlled and the smoothness of operation. It was necessary to replace the inertia lubricators with wick oilers, for the reason that the inertia lubricators

[7] Hazel Atlas Glass Company, Wheeling, W. Va.

would not function because of the smoothness of acceleration in starting and retardation in slowing down and in stopping.

It is the writer's opinion that for freight elevators the two-speed a-c motor drive (6-to-1 ratio) for speeds up to 150 fpm is preferable in that:

1 It eliminates a motor generator set.

2 It also eliminates a commutator type of driving motor.

3 It provides all of the ease of control and smoothness of operation which is obtained with the variable-voltage control.

Comment by C. A. Peters[8]

While the paper is very complete, there are several points which the writer believes can be amplified especially when viewed from the operating angle. Two of these points are (1) the need for careful planning in locating and grouping elevators in office buildings, and (2) the part played by proper maintenance and operation in providing adequate safety.

Location and Grouping of Elevators. The success of an elevator installation in a modern office building is to a substantial degree dependent upon the care used in selecting the location of the elevators and the method of grouping the elevators in one or more banks. Of course where the elevators are grouped in one location as in most of the modern skyscrapers, the problem is fairly simple. However, where a building is of medium height and spread out over a considerable area, or where a building is a combination of tower and spread-out construction, the problem may become very difficult. There is a tendency in such a building to locate the elevators in several groups at different points throughout the building without adequate study to determine which entrances will actually be used by the occupants and visitors to the building. This often leads to an installation which is entirely inadequate, although an ample number of elevators may have actually been installed.

The writer knows of one recent installation where additional cars are badly needed in certain sections of a building, while in another section one group of three cars, representing an expenditure of over $100,000, has never been and never will be used. The reason for this is that the flow of traffic in and out of the building is not through the entrances adjacent to the elevators which are not used.

[8] Buildings Manager, Federal Works Agency, Public Buildings Administration, Washington, D. C.

In several other buildings with which the writer is well acquainted, elevators have been arranged in groups of from two to four without regard to the probable flow of traffic. These elevator installations are not satisfactory and will not adequately handle the traffic, although the buildings contain ample elevator capacity to handle the traffic had the elevators been properly located. In such cases the entire elevator plant, the company which installed the elevators, and the building-operating organization are all condemned for poor elevator service, which is the result of inadequate studies of the probable flow of traffic by the designers and not through the installation of too few elevators.

Safety of Elevators Dependent on Proper Operation and Maintenance. The author has stressed the safety features which are built into the modern elevator. He has also stressed the safety features of the traction machine and modern hoistway construction. These safety features only exist as long as the elevator is subject to adequate and careful maintenance and operation. In this connection, it is believed that a poor installation, well maintained and well operated, is safer than the finest installation with practically no maintenance or care. As an example, we may take the problem of reroping. If a traction elevator is reroped, or has the ropes shortened so that the car can be pulled into the overhead before the counterweight strikes the buffer, practically all of the safety features of the traction machine are lost, and the ropes can be pulled out of the shackles as in the drum machine.

Another example is in the care of the safety mechanism. If this mechanism is not properly inspected and adjusted, it may become entirely inoperative and will not function when the need arises. I know of many cases where this condition has been found to exist, and there are undoubtedly many more cases where car safeties would never function if called into operation.

A great many of the minor accidents occur to passengers entering or leaving elevators through tripping or being struck by closing doors. A well-trained efficient operator will prevent accidents of this type, and such an operator will also prevent a panic or other disturbance in the car should the elevator stop between floors, doors fail to open, or should the safeties be applied.

In this discussion, no attempt has been made to cover the field of general planning or of maintenance and operation but merely to show that there are many other features to be considered in addition to the actual mechanical elevator details, if a safe and satisfactory elevator installation is to be provided.

Author's Closure

The writer mentioned very briefly that the elasticity of elevator ropes gave rise to a number of problems. Mr. Lindquist has made an interesting analysis indicating the oscillatory nature of a system of weights suspended by wire ropes. The ropes, due to their elasticity, have the properties of springs modified by the damping effect of frictional losses in the rope. The backlash of governor ropes that Mr. Davies mentioned is another manifestation of the elastic properties of wire rope. Governor jaws should not depend upon the pull of the governor rope to keep them in a gripping position.

In an elevator system braking takes place under a variety of conditions. One is the case discussed by Mr. Lindquist, in which a substantially constant braking action is applied at the car. This may be either with the compensator free or locked down. Braking may be applied at the sheave as in the case of the service brake. When the car strikes the buffer the braking action applied at the car is variable and another set of conditions is present. In practice, all three of the braking actions may be applied simultaneously. Another variable is motor torque which may be positive, negative, or zero. The effect is different for the various positions of the car in the shaft, because the natural frequency of the system varies with different lengths of the rope sections.

Fortunately, it has been known for some time that suddenly applied acceleration is undesirable. As Bassett Jones points out, the problem is tied up with the third derivative of space with respect to time or, in other words, with the rate of change of acceleration. Experience indicates that if service brakes and car safeties are designed to apply the full braking action, not instantaneously, but gradually, over an interval of time, objectionable oscillatory effects are greatly reduced.

Space will not permit of a full discussion. It may be repeated, however, that a wire rope is a very complicated mechanism and, unfortunately, one about which very few technical data are available.

Mr. Davis has brought out the fact that with high-rise traction elevators the weight of the ropes on the opposite side of the sheave will provide sufficient traction to pull either the car or counterweight into the overhead, in case the limit switches fail and the machine continues to rotate at the limits of travel. This problem exists and must receive careful consideration on each installa-

tion. A solution which has been used in many high buildings is to lock down the compensating sheave. In this case the pull of the compensating ropes will be sufficient to cause slippage at the rope sheave and prevent serious overtravel.

The discussions of Messrs. J. A. Dickinson, Laurence Meharg, and C. A. Peters bring out the importance of correct elevator application. The traffic problem in each building and each material-handling problem is peculiar to itself and must receive individual study. Too frequently lack of proper consideration, or the rule of thumb, instead of scientific methods has resulted in unsatisfactory elevator service. The application of elevators is an engineering problem of considerable magnitude, and should be so treated, when new elevators are to be installed or older ones modified.

More Output Per Man

To the Editor:

Our greatest progress in the furtherance of our present war effort is not going to be by building more plant but by using more efficiently the plant we have. The greatest error we have made so far is that we think of production in terms of man-hours rather than in terms of what that man in that hour can do.

When we begin to increase the efficiency of our present operations it will be a very simple thing to double our present production with the same number of man-hours. We can, inside of another few months, double that again if the efficient methods which the industrial geniuses know can be applied and are enthusiastically followed.

As an example of this, in the present building of ships $^1/_8$ and $^5/_{32}$-in. electrodes are largely being used for welding. If these should be changed to $^3/_{16}$ and $^1/_4$ in. the speed of welding would be more than doubled. The cost of the electrode also would be reduced, the production of electrode by the same number of man-hours would be increased, and the reliability of the joint would be increased.

The great problem we have is not more welders, more shipyards, and more men but more efficiency with what we now have. Man-hours alone will never beat the Axis, as we are seeing. The efficiency possible by the application of industrial genius will.

J. F. Lincoln.[9]

[9] President, The Lincoln Electric Company, Cleveland, Ohio. Mem. A.S.M.E.

A.S.M.E. BOILER CODE

Interpretations

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Committee Secretary, 29 West 39th St., New York, N.Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in Mechanical Engineering.

The following revised wording of Case No. 968 was approved by the Executive Committee of the Boiler Code Committee at a meeting held on June 11, 1942, action confirmed by the Main Committee at its meeting on June 19, 1942, and subsequently approved by the Council of The American Society of Mechanical Engineers.

Case No. 968

(Special Ruling)

Inquiry: Due to the present need for conserving critical materials, and the improvements in design, construction, and materials, may the design stresses for power-boiler pressure parts and the joint efficiency in fusion-welded construction be increased over present Code requirements?

Reply: It is the opinion of the Committee that drums and headers of power boilers may be constructed with maximum design stresses given in Table P-7 multiplied by 1.25 up to a temperature of 750 F, inclusive, and a welded joint efficiency of 95 per cent may be used in the formulas in Pars. P-180, P-195, and P-268 with the following restrictions:

(1) The calculated thickness, using the 25 per cent increased design stresses, includes an allowance for stress concentration and thinning of sections by corrosion or other causes to a limited extent. After calculating the required thickness of shells and heads for boiler drums, using the increased design stresses permitted by this Case, an additive thickness of 0.1 in. shall be included for thicknesses of 0.4 in. and over. Below a thickness of 0.4 in., the additive thickness shall be one quarter of the calculated thickness.

(2) Excessive stress concentration due to sharp re-entrant angles or abrupt changes in section shall be minimized in design.

(3) Stresses due to hydrostatic head alone, and other stresses which appreciably increase the average stress over substantial sections of shell or head above the allowable design stress, shall also be considered in determining the thicknesses used in construction.

(4) Large temperature differentials in heads or shells shall be avoided or the effect reduced by shields or other suitable means.

(5) These increased design stresses may be used only for hemispherical or ellipsoidal heads. Dished heads, other than hemispherical or ellipsoidal, designed in accordance with the present Code rules, may be used with shells which are constructed in accordance with the rules of this Case.

(6) Openings in the shell requiring reinforcement under Par. P-268 shall have the reinforcement applied uniformly on the inside and outside of the shell. If not so applied, the amount of reinforcement shall be calculated for a required shell thickness using design stresses from Table P-7. Openings in the heads may have reinforcement on the outside only.

(7) All stays, braces, and parts requiring staying shall be calculated by the present rules.

The maximum allowable working pressure for tubes for water-tube boilers as given in Table P-2, and by the formulas with Table P-2, may be increased by multiplying the values by 1.25 for temperatures up to 750 F, inclusive. For tubes complying with Specifications S-17, S-32 grades A and B, and S-40 only, 30 lb per sq in. shall be deducted from the pressure so determined.

Boilers constructed in accordance with the requirements of this Case and other applicable Code rules are considered safe and shall be stamped in accordance with Par. P-332, the Code symbol stamp to be followed by the letters "NE," which also shall be shown on the manufacturer's data report.

This Case shall be effective until it is annulled, revised, or Code revisions made.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The Dynamics of Industrial Democracy

The Dynamics of Industrial Democracy. By Clinton S. Golden and Harold J. Ruttenberg. Harper & Brothers, New York, N. Y., 1942. Cloth, $5^1/_4 \times 8$ in., 358 pp., \$3.

Reviewed by J. M. Juran[1]

THOSE industrialists who still hope for a return to the good old days when Unions were not in flower might well characterize "The Dynamics of Industrial Democracy" as Labor's "Mein Kampf." To the extent that the book expounds a philosophy plus a plan for putting the philosophy into effect, the parallel is striking. But there the parallel ceases, for the authorship of this forceful book is not that of the fanatic nor even that of the zealot. Rather the authorship reflects great restraint from emotionalism. Rather there is present an obvious sincerity of purpose, with a wholesome sense of humor always ticking in the background as a balance wheel.

At the very outset the authors propound a series of propositions—thirty seven of them—as valid principles of union-management relations. Some of these admit of little debate and appear to be stated only because the authors have encountered in actual practice too many instances in which such principles are not followed. Other propositions contain elements which are not yet resolved but which are currently being debated in the press. Still others contain elements which are so new to the orbit in which they are intended to operate that the debate has hardly gotten under way. Collectively these propositions are a gage against which a management of today can place its own concepts to judge the extent to which such concepts conform to the world as Industrial Unionism would like to have it.

In support of these principles the authors have drawn from their experiences among men in the steel mills. Their narratives are to the point and with a full flavoring of the virile language which created them. Their arguments are those of men bold through success—vigorously stated, scornful of any apologia, and contemptuous of any but the strongest opposition. Nor is there any absence of chivalry, for the arguments of respected foes are quoted freely amid unconcealed admiration.

Throughout the book there appears and reappears the fact that Messrs. Golden and Ruttenberg know their subject. Is it industrial psychology—their knowledge of the significance of the Hawthorne experiments might well be envied by many industrialists. Is it job ownership—one must admire how well they have drawn the parallel between job ownership and land ownership. Nor have they shrunk from discussion of many highly debatable issues, and with a logic well aimed and precisely stated.

That tender topic "Necessity of Union Shop" is given an unusually complete going over. With fine disdain, the authors first state management's arguments in a way which could do credit to an alert personnel department. Then, having teed these arguments up, the authors proceed to answer them with the easy confidence and obvious relish of men who feel that they have explored the subject far more thoroughly than have their opponents.

The meeting of the National Industrial Conference Board alluded to on page 216 is within the memory of this reviewer. Following Mr. Ruttenberg's address, there was presented during the discussion period that amazing spectacle of a complete disagreement without the parties knowing why it was they disagreed—just where it was that the road began to fork. It appears to this reviewer that management has yet to publicize the best argument against the union shop—the argument that under the union shop, the right to tax and police the minority is in the hands of men not responsible to the vote of the general public. The analogies offered by the Unions, relating to the public-health authorities and other public bodies who have the right to tax and police the minority, are all cases in which the leaders *are* responsible to the vote of the general public.

The discussion of piece rates as a basis for distribution of earnings is not entirely coherent. On the one hand (p. 183 *et seq*) piecework is good if the union has a voice in establishing the piece rates. "Give workers as a formally organized group a say-so in setting wage rates, work standards, job evaluations, and in making time and motion studies, and they will produce all they can within the limitations of physical endurance, health, and fatigue; deny workers such a say-so and they will engage in restrictive practices out of self-protection." On the other hand (p. 308 *et seq*) piecework is growing obsolete because the power age is rendering muscular power obsolete. Is the power age also to render human competition obsolete?

The book is admittedly partisan in nature. It seems, however, that the partisanship relates more to the question of what is discussed and what is omitted than to the question of what is right or wrong with respect to the subjects discussed. The book skirts completely about the subjects of labor racketeering, jurisdictional strikes, struggle among union leaders for power, and other incidents which can rise in frequency and intensity as unionism gains in extent. Such gross omissions from the field of "Industrial Democracy" constitute a serious limitation on the usefulness of this book as a realistic reflection of the position of Industrial Unionism.

The entire discussion of union-management co-operation is largely based on there being available a fund of union leadership of exceedingly broad caliber. The discussion on responsibility for productive efficiency implies that among the workmen and labor leaders is to be found a high degree of engineering ability. It is not the first time in which a new system of operation has been proposed with the tacit assumption that to run the new system there will be available a better breed of humans than run the existing system.

The case histories of union-management co-operation are nevertheless as realistic as a stop sign. They are arresting to a profit-minded owner, and

[1] Assistant Administrator, Office of Lend-Lease Administration, Washington, D. C. Member of Executive Committee of A.S.M.E. Management Division.

they appeal to the purist in management engineering as showing how the principles of scientific management are always awaiting application, quite irrespective of whose hand does the applying.

Notwithstanding the evident and admitted partisanship, no student of union-management relations can lightly pass by the outstanding contribution made by this book. Perhaps of greatest significance is the lucidity with which fundamentals are expounded. It has long been known to observers that the differences between industrialists and unions were in conflicting fundamentals rather than in any conflicting logic flowing from like fundamentals. It is this basic difference which has left managers and labor leaders groping about like two players on the same board, one using checkers and the other using chess pieces, and each astonished at the unorthodox moves being made by his opponent. Messrs. Golden and Ruttenberg make it abundantly clear which game they are playing.

Knowledge of what game is being played by the unions is certainly a sensible prerequisite to any effort to secure enduring industrial peace. Yet this simple accomplishment appears to have far to go. Labor speakers are still a rarity at meetings of industrialists. Labor's engineers are still few in engineering and management societies. And labor executives are still pariahs in Chambers of Commerce.

Clearly, union-management co-operation will meet with considerable resistance because it can be and is being viewed as an obvious step toward collective management, a lump of sugar in one hand and a halter in the other. The proposals for industry-wide bargaining, culminating in national democratic planning will be viewed with even more suspicion. An American University of Labor and Management (p. 69) would be in point to explore some of these proposed relationships. The idea of a forum where these problems can be discussed in an air of detached reflection, free from prior commitments and free from the need for face saving, seems so entirely sound that one wonders why such an idea has made so little headway.

Those who read this book with an open mind will experience all the exhilaration of an intellectual cocktail. Despite this, it is safe to say that before the proposals of Messrs. Golden and Ruttenberg become effective, many more industrialists may have gone down fighting. And if we are to judge by the results of the last decade, that is exactly what will happen.

Your Career in Engineering

YOUR CAREER IN ENGINEERING. By Norman V. Carlisle. E. P. Dutton & Co., New York, N. Y., 1942. Cloth, $5^1/_2 \times 8$ in., 253 pp., $2.50.

REVIEWED BY R. L. SACKETT[2]

THERE are two excellent features of this volume. First, it is written *to* and *for* boys in words with which they are familiar and about incidents that interest them. It is journalistic and colloquial in form—more emotional than rational.

Second, it is illustrated by excellent and well-selected photographs that portray the tools as well as the triumphs of engineering.

About ten pages are devoted to each of the seven major divisions of engineering, including military engineering.

Then follow chapters on the principal subdivisions. In civil engineering these are highway, hydraulic, sanitary, structural, and agricultural engineering.

In the field of mechanical engineering the subtopics are aeronautical, automotive, railway mechanical, and heating, ventilating, and air conditioning.

Under electrical engineering, illuminating and communications are explained, and under "Other Specialties" there are descriptions of petroleum, maritime, industrial, and power engineering.

The appendixes contain lists of engineering curricula accredited by the Engineers' Council for Professional Development and lists of technical magazines. Each chapter ends with a short bibliography of pertinent material.

There are unfortunate errors, misprints, loose use of technical words, and faulty proofreading.

The book is readable and informing for boys, with many references to men and their masterpieces to show how engineering has developed.

[2] Chairman, E.C.P.D. Committee on Student Selection and Guidance. Mem. A.S.M.E.

Books Received in Library

INSTRUCTOR'S GUIDE. Dunwoody Series, Machine Shop Training Jobs. American Technical Society, Chicago, Ill., 1942. Paper, $8^1/_2 \times 11$ in., 39 pp., diagrams, charts, tables, $0.75. This instructor's guide furnishes helpful information and suggestions regarding the use of any or all of the units of the Dunwoody series of manuals on lathe, drill press, milling machine, grinder, shaper and planer, and bench work. It covers the use of the manuals themselves, the organization and control of the training experience, and methods of instruction.

INTRODUCTION TO CHEMICAL THERMODYNAMICS. By L. E. Steiner. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1941. Cloth, $6 \times 9^1/_2$ in., 516 pp., diagrams, charts, tables, $4. The author of this new text aims to acquaint the student with the fundamental theory of thermodynamics and of the relations between the thermodynamic functions; to prepare him to utilize the various tables of thermodynamic data and the data found in chemical literature; and to give him a sound background for more extended work in thermodynamics. To this end the book deals with the basic laws and concepts of thermodynamics and with their application both to relatively simple chemical systems and to nonideal systems where the concepts of partial molal quantities and activities are useful.

INTRODUCTION TO HEAT TRANSFER. By A. I. Brown and S. M. Marco. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1942. Cloth, $6 \times 9^1/_2$ in., 232 pp., diagrams, charts, tables, $2.50. In this book the authors' purpose is to present the essential fundamentals of heat transmission in a treatment that is readily comprehensible and at the same time fairly comprehensive. Emphasis is placed upon acquiring a clear conception of the manner in which heat is transmitted and upon development of the fundamental mathematical expressions which apply to calculations of heat transfer through clean surfaces.

LATHE JOB TRAINING UNITS. Dunwoody Series, Machine Shop Training Jobs. American Technical Society, Chicago, Ill., 1942. Paper, $8^1/_2 \times 11$ in., 143 pp., illus., diagrams, charts, tables, $1.35. First of a series of six manuals, this book presents practical instruction in lathe work. Instruction sheets with full details are given for various jobs on engine and turret lathes and hand screw machines. Necessary drawings are included, and a sheet of review questions is provided for each job.

LOCOMOTIVE CYCLOPEDIA of American Practice, eleventh edition, 1941. Compiled and edited for the Association of American Railroads—Mechanical Division; edited by R. V. Wright and R. C. Augur. Simmons-Boardman Publishing Corporation, New York, N. Y., 1941. Cloth, 8×12 in., 1312 pp., illus., diagrams, charts, maps, tables, $5. In the eleventh edition of this well-known reference work, as in previous ones, considerable revision has occurred both in the text and in the arrangement and indexing. By the addition of new material, such as the chapter

Library Services

ENGINEERING Societies Library books may be borrowed by mail by A.S.M.E. members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Harrison W. Craver, Director, Engineering Societies Library, 29 West 39th St., New York, N. Y.

on welding and cutting in locomotive shops, the book remains representative of the latest practice in locomotive design, construction, and maintenance. In order to keep the book to a reasonable size little except current practice is included, and previous editions should be consulted for information on older locomotives.

MACHINE SHOP WORK. By J. T. Shuman and others. American Technical Society, Chicago, Ill., 1942. Cloth, $5\frac{1}{2} \times 8\frac{1}{2}$ in., 499 pp., illus., diagrams, charts, tables, $3.50. The fundamentals and principles of modern machine-shop practice are described, including all major machines and operations rather than merely typical ones. A trouble-shooting page accompanies each chapter, listing common operating difficulties, probable causes, and suggested remedies. Review questions are also provided for each chapter.

MECHANICS OF FLUIDS. By G. Murphy. International Textbook Co., Scranton, Pa., 1942. Fabricoid, $5 \times 8\frac{1}{2}$ in., 329 pp., illus., diagrams, charts, tables, $3.25. In this introductory textbook on the behavior of fluids, the approach and techniques are those which have proved successful in the mechanics of solids. The basic method of analysis is that of the free-body, used in conjunction with the fundamental principles of mechanics, expressed in Newton's laws of motion. Numerous practical applications of the theory are cited, and numerical and laboratory problems are provided.

METALLURGICAL AND INDUSTRIAL RADIOLOGY. By K. S. Low. Sir Isaac Pitman & Sons, Ltd., London, England; Pitman Publishing Corporation, New York, N. Y., 1940. Cloth, $5 \times 7\frac{1}{2}$ in., 88 pp., illus., diagrams, charts, tables, $2.50. The obvious advantages of nondestructive testing and examination of objects indicate the increasing importance of radiological methods. The general principles, apparatus and equipment, and methods of radiographic technique in metallurgical work are described, and the interpretation of radiographs is explained. Certain specialized practices are also briefly discussed.

METALLURGY. By C. G. Johnson. American Technical Society, Chicago, Ill., 1942. Cloth, $5\frac{1}{2} \times 8\frac{1}{2}$ in., 262 pp., illus., diagrams, charts, tables, $2.50. The purpose of this textbook is to present information on the subject of metals in such a way that the average untrained person will be able to obtain some working knowledge of the manufacture and behavior of metals and their alloys. The questions at the end of each chapter help the student to check his understanding of the material covered, and a list of books and magazines useful for further reference is provided.

MILLING MACHINE JOB TRAINING UNITS. Dunwoody Series, Machine Shop Training Jobs. American Technical Society, Chicago, Ill., 1942. Paper, $8\frac{1}{2} \times 11$ in., 110 pp., illus., diagrams, tables, $1.25. This book covers jobs in connection with setting up and operating various types of milling machines, and forms part of a series of six manuals for training on different machine tools. A job check-sheet accompanies every job in order to test the learner's understanding before he starts on the job itself. Hints on blueprint reading and a list of useful shop-knowledge items are included.

MODERN ASSEMBLY PROCESSES, Their Development and Control. By J. L. Miller, with a foreword by E. A. Watson. Chapman & Hall, London, England, 1941. Cloth, $5\frac{1}{2} \times 9$ in., 168 pp., illus., diagrams, charts, tables, 13s 6d. This book deals with the processes used to assemble small parts in large-scale production. In surveying these processes the book describes recent developments, shows how the processes may be controlled, and discusses the factors which influence both the designer and the production engineer in the choice of the process to be used.

MODERN PULP AND PAPER MAKING, a Practical Treatise. By G. S. Witham. Second edition. Reinhold Publishing Corporation, New York, N. Y., 1942. Cloth, $6 \times 9\frac{1}{2}$ in., 705 pp., illus., diagrams, charts, tables, $6.75. The purpose of this treatise is to give a general, practical account of the equipment and processes used in American pulp and paper plants. The new edition has been thoroughly revised to include developments since the first edition appeared in 1920, and the material has been arranged more logically.

MODERN SMALL ARMS. Compiled by *Steel*, Penton Publishing Co., Cleveland, Ohio, 1942. Paper, $9 \times 11\frac{1}{2}$ in., 66 pp., illus., diagrams, charts, tables, $1. This third of a series of handbooks on armament production compiled by the magazine *Steel* contains reprints of articles describing the construction and operation of various types of semiautomatic, machine, and sub-machine guns. The types of small-arms ammunition and representative manufacturing processes for cartridge cases are also described.

MODERN STRIP MILL, edited by T. J. Ess and J. D. Kelly. Association of Iron and Steel Engineers, Pittsburgh, Pa., 1941. Two parts bound in one. Part 1, 358 pp.; part 2, 127 pp. Leather, $9 \times 12\frac{1}{2}$ in., illus., diagrams, charts, tables, blueprints, $15; to libraries $10; outside of United States $20. This important volume, based upon articles that have appeared in the *Iron and Steel Engineer*, provides a detailed, complete review of the development of the continuous wide-strip mill. The first section discusses mill equipment, unit by unit, with a great fund of operating data for each group. The second section contains descriptions, with layout drawings, of the twenty-eight mills now operating in the United States. An immense amount of information, based upon actual operation, is supplied.

OPERATIONAL METHODS IN APPLIED MATHEMATICS. By H. S. Carslaw and J. C. Jaeger. Oxford University Press, London, England, and New York, N. Y. Cloth, $5\frac{1}{2} \times 9$ in., 1941. 264 pp., diagrams, tables, $5. By applying the Laplace transformation to the differential equations previously treated by the Heaviside operational calculus, a substitute for these operational methods can be obtained. The object of this book is to describe this simple and effective new method and to show its use in various branches of applied mathematics such as electric circuit theory, the conduction of heat, hydrodynamics, etc. A group of miscellaneous examples which involve partial-differential equations is appended.

OPTIMUM HOURS OF WORK IN WAR PRODUCTION. Research Report Series No. 65. By J. D. Brown and H. Baker. Princeton University, Industrial Relations Section, Princeton, N. J., March, 1942. Paper, 7×10 in., 25 pp., tables, $0.75. Based on information obtained from 140 companies in war production, this pamphlet presents experiences with various work schedules of from 40 to 60 hours per week and from 5 to 7 days per week. The several important factors in the determination of optimum hours (physical effort, rest periods, labor supply, etc.) are discussed and conclusions drawn.

OUTLINES OF FOOD TECHNOLOGY. By H. W. von Loesecke. Reinhold Publishing Corporation, New York, N. Y., 1942. Cloth, $6 \times 9\frac{1}{2}$ in., 505 pp., illus., diagrams, charts, tables, $7. The purpose of this book is to outline the more important processes used in preparing, preserving, and storing all kinds of foodstuffs. Detailed descriptions have not been attempted, owing to the breadth of the field, but suggestions for further reading are appended to each chapter. Analyses and many other technical data are included, but no attempt has been made to discuss nutritive values.

PHYSICAL EXAMINATION OF METALS, Vol. 2. Electrical Methods. By B. Chalmers and A. G. Quarrell. Longmans, Green & Co., New York, N. Y.; Edward Arnold & Co., London, England, 1941. Cloth, $5\frac{1}{2} \times 8\frac{1}{2}$ in., 280 pp., illus., diagrams, charts, tables, $6. This second of two volumes on the application of the various branches of physics to the examination of metals deals with magnetic, electric, electronic, and X-ray methods. Underlying physical theories are explained, the apparatus and more important applications are described, and some discussion of operational techniques is included.

PILOTS' AND MECHANICS' AIRCRAFT INSTRUMENT MANUAL. By G. C. DeBaud. Ronald Press Co., Inc., New York, N. Y., 1942. Cloth, 6×9 in., 490 pp., illus., diagrams, charts, tables, maps, $4.50. This textbook on aircraft instruments is designed to meet the requirements of thorough, systematic courses in technical and aviation schools, and the needs of those who wish to acquire an understanding of instruments without an instructor's guidance. The chapters of the book are so arranged that the user will progressively understand the construction, purpose, and necessity of the instrument, likely errors with their remedies, installation, and maintenance. There is also a brief outline of instrument-flying training.

PLASTICS IN ENGINEERING. (Machine Design Series.) By J. Delmonte. Second edition. Penton Publishing Co., Cleveland, Ohio, 1942. Cloth, $6 \times 9\frac{1}{2}$ in., 601 pp., illus., diagrams, charts, tables, $7.50. Intended for the machine designer and manufacturer rather than the chemist, this work aims to present the data needed by designers in convenient form for reference. The opening chapters review the various types of plastics, methods of compounding, and physical and chemical properties. Succeeding chapters discuss methods of molding, uses for bearings, gears, and other machine parts, engineering applications, fabrication and finishing of plastic parts, etc. The revision in the new edition has been influenced by the ever increasing need of substitutes for a great many strategic metals.

POSSIBLE ALTERNATES FOR NICKEL, CHROMIUM AND CHROMIUM-NICKEL CONSTRUCTIONAL ALLOY STEELS. (Contributions to the Metallurgy of Steel, No. 5.) American Iron and Steel Institute, New York, N. Y., January, 1942. Paper 6×9 in., 143 pp., charts, tables, $0.50. This timely pamphlet presents four new series of alloy steels designed to preserve our reserves of strategic metals, especially chromium and nickel. The steels developed embrace a series of carbon-molybdenum, manganese-molybdenum, low chromium-molybdenum and low nickel-chromium-molybdenum steels. Data are given about hardenability and other physical properties.

POWER PLANT ENGINEERING AND DESIGN. By F. T. Morse. Second edition. D. Van Nostrand Co., Inc., New York, N. Y., 1942. Cloth, $6 \times 9^1/_2$ in., 703 pp., illus., diagrams, charts, tables, $6.50. The aim of this book is to present in one volume a study of electric generating stations, including public service, industrial, and institutional plants. Attention is paid to both mechanical and electrical features and to economic factors. Steam plants are given most attention, but hydroelectric and Diesel-engine plants are also considered. The comprehensive nature of this one-volume text has been attained by assuming a basic knowledge of thermodynamics and mechanics and by omitting minor details of plant equipment and layout.

PRINCIPLES OF MECHANICS. By J. L. Synge and B. A. Griffith. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1942. Cloth, $6 \times 9^1/_2$ in., 514 pp., diagrams, tables, $4.50. This textbook on theoretical mechanics covers the usual range of theory and applications, up to and including an introduction to Lagrange's equations, with emphasis on general principles and underlying philosophical ideas. Vector notation and the complex variable are used wherever they provide the most efficient tools. A chapter on the special theory of relativity is included.

PRODUCTION CONTROL. By L. L. Bethel, W. L. Tann, F. S. Atwater, and E. E. Rung. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1942. Cloth, $6 \times 9^1/_2$ in., 276 pp., illus., diagrams, charts, tables, $2.75; accompanying Teachers' Manual, by L. L. Bethel, paper, $5^1/_2 \times 8$ in., 19 pp., $0.10. The principles and procedures for planning and controlling industrial production are covered. Broad factors of production management and of operation control are also included. Case problems, taken from current industrial practices, illustrate the applications of principles. Appendixes contain a portion of the written standard practice of an actual company, sample production-control forms, and an example of a typical job-order production-control system.

REFINERY CATALOG, a Composite Catalog of Oil Refinery Equipment, including Process Handbook and Engineering Data; published by *The Refiner and Natural Gasoline Manufacturer*, Houston, Texas, 1940. Ninth edition. Cloth, 8×12 in., 529 pp., illus., diagrams, charts, maps, tables, blueprints, apply. The catalog presents data on equipment for oil refineries and natural-gasoline plants supplied by over two hundred manufacturers. In addition the book contains a section on processes, which contains descriptions and flow sheets for many important processes used in refining and treating petroleum and natural gasoline, and a collection of tables frequently wanted in refinery operation.

S.A.E. HANDBOOK, 1942 Edition. Society of Automotive Engineers, New York, N. Y., 1942. Cloth, $5^1/_2 \times 8^1/_2$ in., 828 pp., illus., diagrams, charts, tables, $5; $2.50 to members. All the current standards and recommended practices of the Society of Automotive Engineers concerning automobile and aircraft materials and parts, tests and codes, production equipment, nomenclature, and definitions are contained in this annually revised handbook. The numerous changes include new and revised standards, corrections, and cancellations. There is also a partial list of American standards of interest to the automotive industry.

SAFETY SUPERVISION. (The Pennsylvania State College, Industrial Series.) By V. G. Schaefer. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1941. Cloth, $5 \times 7^1/_2$ in., 352 pp., tables, $2.50. The purpose of this book is to discuss the human element involved in the problems of the supervisor who must promote the safety of the workers in his division. It presents the duties, responsibilities, methods, and techniques of safety supervision as elements of personnel management, and makes no attempt to discuss engineering problems of safety or the making of accident records and reports.

SCIENCE AND PRACTICE OF WELDING. By A. C. Davies. The Macmillan Co., Inc., New York, N. Y., University Press, Cambridge, England, 1941. Cloth, 5×8 in., 436 pp., illus., diagrams, charts, tables, $2.25. This text provides a concise, yet comprehensive, account of the basic theoretical principles underlying the various processes of welding and of the practical methods of applying them. Both gas and electric methods are covered, and there are chapters on gas cutting and on inspection and testing.

SCIENTISTS FACE THE WORLD OF 1942, Essays by K. T. Compton, R. W. Trullinger, and V. Bush. Rutgers University Press, New Brunswick, N. J., 1942. Cloth, $6 \times 9^1/_2$ in., 80 pp., tables, $1.25. The three essays by eminent scientists which are contained in this volume present, respectively: An integration of the fundamental sciences of physics, chemistry, and biology as they are applied to engineering in a time of national emergency; a discussion of the philosophy and technique of biological engineering as applied to the problems of food, health, etc.; and a description of the application of the well-known principles of engineering to the complex phenomena of the farm. Commentaries are appended.

SHOP THEORY, revised edition, prepared by the Shop Theory Department, Henry Ford Trade School, Dearborn, Mich. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1942. Paper, 9×11 in., 267 pp., illus., diagrams, tables, $1.25. The various tools and machines used in a machine shop and the operations which can be performed by them are described in detail. Heat-treatment, abrasives, and the routing of bench-tool work are other topics covered. The manual is profusely illustrated, and problems and review questions are included in many of the chapters.

TABLES OF THE MOMENT OF INERTIA AND SECTION MODULUS OF ORDINARY ANGLES, CHANNELS, AND BULB ANGLES WITH CERTAIN PLATE COMBINATIONS, prepared by the Federal Works Agency, Work Projects Administration for the City of New York, as a report of Official Project No. 165-2-97-22, Mathematical Tables Project; conducted under the sponsorship and for sale by the National Bureau of Standards, Washington, D. C., 1941. Cloth, $8 \times 10^1/_2$ in., 197 pp., tables, $1.25 (payable in advance). This new volume in the series of mathematical tables sponsored by the U. S. Bureau of Standards presents tables of the moment of inertia and section modulus of ordinary angles, channels and bulb angles with certain plate combinations. Tables of various dimensional properties of these structural shapes are appended.

TECHNIDATA HAND BOOK, Engineering, Chemistry, Physics, Mechanics, Mathematics. By E. L. Page. Norman W. Henley Publishing Co., New York, N. Y., 1942. Paper and cloth, $5^1/_2 \times 8^1/_2$ in., 64 pp., diagrams, charts, tables, loose-leaf, paper, $1; cloth, $1.50. Essential data taken from the fields of mathematics, physics, chemistry, and engineering mechanics are presented in condensed form. Facts, figures, theory, definitions, laws, formulas, simple calculations, diagrams, and numerical tables are all utilized. The use of the slide rule is also briefly exemplified.

THIS CHEMICAL AGE, the Miracle of Man-Made Materials. By W. Haynes. Alfred A. Knopf, New York, N. Y., 1942. Cloth, $5^1/_2 \times 8^1/_2$ in., 385 pp., illus., charts, maps, tables, $3.50. The reader without a chemical background will find this an interesting account of modern developments in this field. The ways in which laboratory discoveries have been developed into such industrial products as dies, drugs, plastics, nylon, cellophane, and synthetic rubber are described clearly and dramatically, with scientific accuracy, a thoroughly readable book.

THOMAS' REGISTER OF AMERICAN MANUFACTURERS, thirty-second edition, 1942 (December, 1941). Thomas Publishing Co., New York, Boston, Chicago, Cleveland, Detroit, Los Angeles, Philadelphia, Pittsburgh, San Francisco, Toronto (Canada), and London (England), 1941. Cloth, 9×14 in., 5200 pp., illus., initial subscription, $15; renewal, $10 (supply limited). This huge annual compilation of American manufacturers has its customary three main sections: The classified directory of products (with index) in which the firms are listed, with a capital rating, geographically under each product; the alphabetical list of manufacturers, giving addresses, subsidiaries, branches, etc.; and the trade-name index. The newer arbitrary numbering of advertisers, with a separate key index which lists these numbers with their corresponding companies, is continued, chiefly for the use of purchasing agents.

UNIFORMITY IN HIGHWAY TRAFFIC CONTROL. By W. P. Eno. The Eno Foundation for Highway Traffic Control, Saugatuck, Conn., 1941. Paper, 5×7 in., 83 pp., diagrams, illus., $1. The basic principles of traffic control as developed by the author during the last forty years are summarized for general use. Topics covered include police enforcement, licensing, traffic aids, pedestrian rules, parking, one-way traffic, and noise reduction. The necessity for uniformity is stressed.

WAGE INCENTIVE METHODS, Their Selection, Installation, and Operation. By C. W. Lytle Revised edition. Ronald Press Co., New York, N. Y., 1942. Cloth, $6 \times 9^1/_2$ in., 462 pp., diagrams, charts, tables, $6. The aim of this book is to facilitate the selection of the best wage plan for any business, by providing means for comparison of possible methods. It presents all the basic incentive plans in use, with their variations and modifications. Some two dozen different plans are described and analyzed in detail and their strong and weak points presented impartially. This edition has been further revised.

WÄRMETECHNISCHE RECHNUNGEN FÜR INDUSTRIEÖFEN. (Stahleisen-Bücher, Band 2.) By W. Heiligenstaedt. Second revision and enlarged edition. Verlag Stahleisen, Düsseldorf, Germany, 1941. Cloth, $6^1/_2 \times 9^1/_2$ in., 332 pp., diagrams, charts, tables, 19.20 rm. (14.40 rm. in U. S. A.). This book discusses the thermal calculations required by the designer and operator of industrial furnaces. Essentially practical in intent, the theoretical material is expressed, wherever possible, in numerical tables, formulas and rules for various calculations. Heat balance, combustion, heat transfer, conduction, and the heating process are considered, with many worked-out examples of calculations. This second edition is considerably enlarged and contains a bibliography.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

A.S.M.E. Fall Meeting, Rochester, Oct. 12–14, to Be Engineering Conference for Victory

SAGAMORE HOTEL, HEADQUARTERS FOR A.S.M.E. FALL MEETING IN ROCHESTER, OCT. 12–14

IN spite of war conditions of travel and all-out production, The American Society of Mechanical Engineers, after a thorough study of the needs of the times, has decided to go through with plans for the 1942 Fall Meeting announced for Rochester, N. Y., October 12 to 14. Increased production is the great need of the nation at the present time and the responsibility for maintaining production at a high rate rests with mechanical engineers. Whatever contributes to the efficiency and "know-how" of these men contributes to the ultimate victory. Engineering conferences of the type planned for Rochester offer opportunity for engineers to exchange valuable experiences with one another and to learn from one another's errors and successes.

Registration will start at 2 p. m., Sunday, October 11, at the Headquarters at the Sagamore Hotel. A meeting of the Executive Committee of the Council of the A.S.M.E., committee meetings, and finally a dinner of the Council and committee members, terminating in a get-together in the evening will take up the day, preparatory to the actual opening of the meeting on Monday morning, October 12.

Sessions of Vital Importance

While the detailed program is not as yet in its final form, many of the sessions are arranged and these bid fair to make this meeting so valuable that every member of the Society who can possibly get to Rochester will find himself more than repaid.

Aviation papers are scheduled to cover the modern tricycle landing gear, plastics in aircraft manufacture, design-strengthened sheet and strip for aircraft construction, bevel gear in aircraft, and production methods—all of vital interest at the moment.

Sessions on wood industries will feature the effect of wood structure upon heat conductivity, high-frequency heat for gluing and drying lumber, and prefabrication housing.

A session on industrial salvage will be sponsored by the Management Division to cover such topics as getting the maximum yield from raw materials and salvaging various types of scrap.

Women in Industry

The Management Division of the A.S.M.E. is also preparing one session, which will be of more than ordinary interest—women in industry. Experts will handle various phases of the problems involved, among them being Dr. Leonard Greenburg, executive director of the division of industrial hygiene, department of labor, State of New York, and L. L. Park, superintendent of welfare, American Locomotive Company, Montreal, Canada.

The Committee on Education and Training for the Industries is also interested in the subject of women in industry and is planning a session in which Robert H. Baker and Mrs. O. S. Reimold, of the War Industries Training School of Stevens Institute of Technology, will explain what can be done to train women for engineering jobs. At the same session Elizabeth M. G. MacGill, chief aeronautical engineer of the Canadian Car & Foundry Co., Canada, will read a paper.

There is also being prepared a panel discussion on education for industry, with Carl L. Bausch as leader of the discussion.

Other sessions will be sponsored by the Power Division, the Committee on Industrial Instruments and Regulators, and Materials Handling Division.

A symposium on heavy machine tools and papers on precision jigs and fixtures and optical devices in the machine shop will be sponsored by the Production Engineering Division.

Plant Visits Being Arranged

Tuesday and Wednesday afternoons have been left open for plant visits. Although arrangements have not been completed and may

MAIN STREET, ROCHESTER, N. Y., LOOKING EAST FROM EXCHANGE STREET

have to be altered as conditions change, the Rochester committee is endeavoring to provide opportunites for visiting engineers to see a variety of plants and educational institutions. The Gleason Works, Eastman Kodak Company, and Hickey-Freeman have already expressed willingness to co-operate and negotiations are under way with others where permission of government agencies is yet to be obtained.

The Rochester Committee announces that it will be necessary for members to register for these plant trips well in advance of the meeting date. For visits to plants which are under the jurisdiction of the Army or Navy Ordnance Departments, members will need to submit a birth certificate at the time of registration.

Heads Rochester Committee

The meeting at Rochester is under the guidance of a committee headed by Virgil M. Palmer, superintendent of the Industrial Engineering Department, Eastman Kodak Company. T. F. Hooker is in charge of the technical program, and C. C. Ross is making arrangements for plant trips.

The officers of the A.S.M.E. Rochester Section are W. D. Wood, chairman, A. W. Schuster, vice-chairman, and I. G. McChesney, secretary-treasurer.

A.S.M.E. Calendar
of Coming Meetings

Sept. 30–Oct. 1, 1942
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
St. Louis, Mo.

October 12–14, 1942
Fall Meeting
Rochester, N. Y.

Nov. 30–Dec. 4, 1942
Annual Meeting
New York, N. Y.

(For coming meetings of other organizations see page 32 of the advertising section of this issue)

M.I.T. Host at National Meeting of A.S.M.E. Applied Mechanics Division, June 19–20

Dr. George de Santillana Speaker at Dinner

THE National Meeting of the Applied Mechanics Division of The American Society of Mechanical Engineers was held on Friday and Saturday, June 19 and 20, at the Massachusetts Institute of Technology in Cambridge, Massachusetts. The meeting was one of the most successful ever held by the Division, with a total registration of 91.

The Session on Photoelasticity

The first technical session on Friday morning was devoted to the subject of photoelasticity in which two papers were presented. The first, by Dr. Durelli of M.I.T., on "Experimental Determination of the Isostatic Lines," described some of the latest developments in the application of brittle lacquers to the determination of stress directions in photoelastic models. The determination of the stress trajectories by means of the isoclinic lines is a difficult and tedious proposition, whereas the new technique permits of photographing the isostatics completely.

In the second paper "The Photoelastic Analysis of Transverse Bending of Plates" Dr. Drucker of Cornell University gave a description of his method for finding stresses in thin curved plates. A known stress condition is frozen into the material which is to be used for the investigation and later models made from the previously stressed material can be set up and examined in the ordinary type of transmission polariscope. The usual type of fringe photograph can be made but the interpretation is somewhat different from that usually employed.

The Session on Equilibrium and Dynamics

At the Friday afternoon session the paper on "Calculation of Load and Stroke in Oil Well Pump Rods," by Messrs. Langer and Lamberger, of Westinghouse Electric and Manufacturing Co., was particularly interesting as many records of stress and displacement were incorporated, as well as an excellent theoretical discussion. The measurement work was particularly ingenious.

"Oscillations of Suspension Bridges," the paper at the same session by Professor Reissner of the Illinois Institute of Technology, dealt largely with the ill-fated Tacoma Bridge from the theoretical side.

In Mr. Adkins' paper on "Virtual Work and Virtual Complementary Work" an advance is marked in methods of calculating many interesting problems of applied mechanics. Wider application of the theories involved will undoubtedly be made in the future.

Dinner—Friday Evening

The dinner was attended by 65 members and guests. In the absence of Dean Edward L. Moreland of M.I.T., who had expected to be toastmaster, Prof. C. Richard Soderberg presided and extended the greetings of the host institution, the Massachusetts Institute of Technology. Prof. J. W. Zeller, the chairman of the Boston local section of the A.S.M.E., welcomed the delegates in the name of his section, and Dr. Hugh L. Dryden, chairman of the A.S.M.E. Applied Mechanics Division, spoke for the Division. Dean Harold M. Westergaard of Harvard University spoke briefly on the history of the Division and its significance in the war.

The principal address of the evening was on the subject "Rankine, or Utility and Philosophy," by Dr. George de Santillana, historian of science. He described the changing philosophy of the scientists of Rankine's day and the contributions that Rankine made to the philosophical evolution of science.

The Session on Elasticity

At the session on Saturday morning Mr. Miller of the Brooklyn Navy Yard in his paper on "An Analytical Method for Determining the Flexibility of Piping Having Two or More Anchorages" discussed a method of determining stresses in a three-dimensional system of piping which has reverse bends and which may have more than two anchorages.

Mr. Levy of the National Bureau of Standards analyzed the buckling of rectangular plates with built-in edges and presented data on buckling loads for plates of various dimensions in a paper entitled "Buckling of Rectangular Plates With Built-In Edges." He also reviewed and compared previous work on the same subject.

DeForest, Ellis, and Stern presented the final paper of the Meeting "Brittle Coatings for Quantitative Strain Measurements." They showed how brittle coatings can be used as both qualitative and quantitative means for determining stresses and stress concentrations. The techniques described are applicable to fillets and corners where even the most minute strain gages would be too large or too awkward.

The program of the technical sessions, listing papers and authors, appeared in the June issue of MECHANICAL ENGINEERING, page 504.

Preliminary Draft of Instruments and Apparatus Section on Resistance Thermometers Completed

Criticism or Comment Welcomed

THE preliminary draft of the Section on Resistance Thermometers is now completed and the A.S.M.E. Power Test Codes Committee on Instruments and Apparatus will welcome criticism or comment on it by members of the Society and others interested. Copies may be obtained by addressing the Power Test Codes Committee, A.S.M.E. Headquarters.

The Committee in charge of this part of the Power Test Codes activity consists of W. A. Carter, chairman, C. M. Allen, W. C. Andrae, E. G. Bailey, H. S. Bean, L. J. Briggs, J. D. Davis, K. J. DeJuhasz, R. E. Dillon, F. M. Farmer, J. B. Grumbein, W. W. Johnson, W. H. Kenerson, E. S. Lee, E. L. Lindseth, O. Monnett, S. A. Moss, R. J. S. Pigott, E. B. Ricketts, W. A. Sloan, R. B. Smith, and I. M. Stein.

This chapter deals with the temperature-sensitive bulb, and remotely located indicating or recording measuring instrument,

and the wiring system between the bulb and the instrument.

The advantages and disadvantages of this type of instrument compared with liquid-in-glass and thermocouple pyrometers are listed. Methods of construction and ranges of use for platinum, nickel, and copper resistance thermometers are discussed. The basic equations relating resistance with temperature are included.

The measuring instruments of both the manually balanced and deflection types are described and shown in circuit diagram. Some instruments have greater inherent limits of error than others. Instructions are given for checking the current flowing through the resistance element in order to establish maximum sensitivity of the instrument without heating the resistance element unduly.

The arrangement of leads between the resistance element and measuring instrument is important because in some cases it is necessary to compensate for their variation in resistance because of changes in their temperatures.

Calibration against appropriate standards are discussed.

S.P.E.E. at 50th Annual Meeting Elects H. T. Heald President

THE Society for the Promotion of Engineering Education held its fiftieth annual meeting in New York, N. Y., with general headquarters at Columbia University. Because of wartime conditions which have imposed "accelerated" programs on engineering colleges the meeting was concentrated in three days, June 27–29, instead of the usual week-long period. The registration was in excess of 300.

Twelve engineering colleges in the metropolitan New York region collaborated in the role of host: The Polytechnic Institute of Brooklyn, The College of the City of New York, Columbia University, Cooper Union, Manhattan College, Newark College of Engineering, New York University, Pratt Institute, Princeton University, Rutgers University, Stevens Institute of Technology, and Webb Institute of Naval Architecture.

Engineering Colleges and the War Effort

The general theme of the meeting, "The Task of the Engineering Colleges in the War Effort," was stressed by a group of distinguished speakers at the general sessions on Saturday and Sunday morning, at which president A. H. White presided, and on Sunday afternoon when vice-president Henry T. Heald acted as chairman.

At the Annual Dinner, held in the John Jay Dining Hall of Columbia University on Sunday evening, Willard T. Chevalier, publisher of *Business Week* gave the principal address entitled, "A Chance and a Challenge."

The Lamme Medal for achievement in Engineering Education was presented to Roy Andrew Seaton, member A.S.M.E., dean of the Division of Engineering and Architecture and director of the Engineering Experiment Station, Kansas State College, and from 1940 to 1942 Director of Engineering, Science, and Management Defense Training, U. S. Office of Education, Washington, D. C.

To W. O. Wiley, treasurer S.P.E.E. for the last 35 years, there was presented a book of letters of appreciation from present and former members of the council. Mr. Wiley was also elected the only honorary member of the Society.

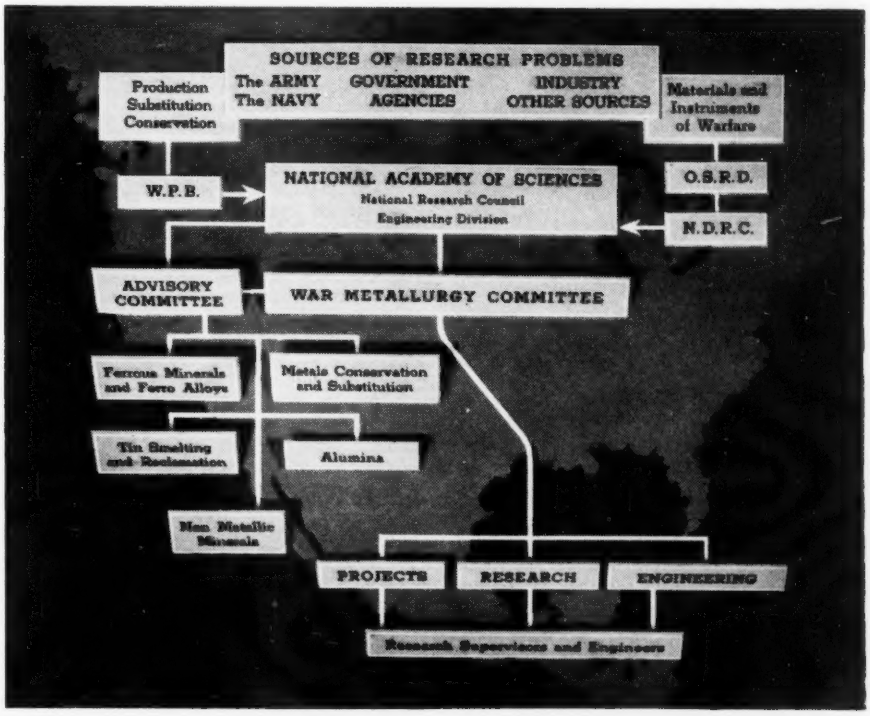
Officers for Coming Year

Officers of the society for the coming year were announced as follows: President, Henry T. Heald, member A.S.M.E., president Illinois Institute of Technology; vice-president, Baldwin M. Woods, member A.S.M.E., professor of mechanical engineering, University of California, Berkeley, Calif.; vice-president, C. E. MacQuigg, dean, College of Engineering and director, Engineering Experiment Station, The Ohio State University; treasurer, James S. Thompson, vice-president, McGraw-Hill Book Company, Inc.; secretary, F. L. Bishop (re-elected) professor of physics, University of Pittsburgh.

Edsel B. Ford President of Rackham Foundation

EDSEL B. FORD was elected to the presidency of the Horace H. Rackham Engineering Foundation to succeed Alex Dow who died on March 22. At the meeting of the trustees held June 11 in the Horace H. Rackham Educational Memorial, Alfred C. Marshall was elected to the board of lifetime trustees and made vice-president in addition to the position of treasurer which he held by appointment prior to this meeting.

The complete personnel of the Foundation now includes: Edsel B. Ford, president; A. C. Marshall, vice-president; Standish Backus, secretary; Bryson D. Horton, and General Wm. S. Knudsen. James W. Parker, past-president, and Harvey M. Merker, president, of The Engineering Society of Detroit, by virtue of their offices are exofficio trustees. Lawrence E. Brown and Col. Douglas Dow are assistant secretaries and E. L. Brandt, resident agent.



THE WAR METALLURGY COMMITTEE

The War Metallurgy Committee is an agency of the National Academy of Sciences and the National Research Council, charged with the conduct of metallurgical research for the War Production Board and the National Defense Research Committee of the Office of Scientific Research and Development.

The committee operates through three major sections: The first, formulating and placing research projects; the second, supervising the operation of these researches; and the third section correlating the committee's work with war metallurgical research of other government agencies, industrial and university research departments, and with foreign research.

The Metals and Minerals Advisory Committee of the Academy serves both the War Production Board and the War Metallurgy Committee on problems involving production, substitution and conservation of strategic materials.

Clyde Williams, director of Battelle Institute, Columbus, Ohio, is chairman of both Committees. Louis Jordan, National Academy of Sciences, Washington, D. C., is executive secretary.

A.S.M.E. Council Actions at 1942 Semi-Annual Meeting

1942-1943 Budget Approved

In connection with the 1942 Semi-Annual Meeting of The American Society of Mechanical Engineers, Hotel Statler, Cleveland, Ohio, the Council and its Executive Committee held several sessions on June 7 and 8 and met with the Committee on Education and Training for the Industries on June 10. James W. Parker, president, presided on all of these occasions.

In addition to Mr. Parker, the following members of the Council and officers of the Society were present at all or some of the sessions: James H. Herron, Warren H. McBryde, A. G. Christie, past-presidents; Samuel B. Earle, Clarke F. Freeman, K. M. Irwin, Clair B. Peck, Frank H. Prouty, and Willis R. Woolrich, vice-presidents; William G. Christy, Huber O. Croft, Paul B. Eaton, Joseph W. Eshelman, Linn Helander, George E. Hulse, and Guy T. Shoemaker, managers; W. D. Ennis, treasurer; and C. E. Davies, secretary. At various times there were present chairmen and members of A.S.M.E. committees, members of the staff, guests, and F. W. Brooks and Eugene Hervey, junior observers.

The following actions are of general interest:

To the Executive Committee the Secretary reported prospects of co-operation of the Society with the Inter-American Development Commission. The President reported the status of a series of War-Production Conferences that were being currently sponsored by six national engineering societies, of which the A.S.M.E. was one, held at the request of Donald M. Nelson, chairman, and William H. Harrison, director of production, of the War Production Board.

Joint Committee on Engineering History

Upon recommendation of Harrison W. Craver, secretary, Joint Committee on Engineering History, it was voted to suggest to the participating societies the disbandment of the joint committee and to withdraw A.S.M.E. representation thereon. The joint committee has been inactive for some time.

E.C.P.D. Not to Curtail Activities

The Secretary read a resolution adopted May 21 by the Executive Committee of the Engineers' Council for Professional Development expressing conviction of the importance of the work of E.C.P.D. in wartime.

Appointments

The following appointments were reported:

Special Research Committee on Forging of Steel Shells: Col. G. Elkins Knable, Col. M. H. Davis, and Lieut. Col. W. W. Holler.

United Engineering Trustees, Inc.: H. A. Lardner (reappointment for a four-year term).

Engineers' Council for Professional Development: R. L. Sackett (three-year term).

Committee on Local Sections

Members of the Committee on Local Sections, J. N. Landis, chairman, met with the Executive Committee to review the committee's problems and interchange ideas. Mr. Landis said that with greater financial support there was a better feeling among section officers and better results were being obtained. Several sections, he said, had co-operated in meetings on war production.

Results of a survey to determine the extent of unionization activities among engineers were summarized. The reports from 16 sections had been delivered to the secretary.

The committee had investigated the usefulness of guest cards at local-section meetings and was placing the results before all sections.

The subject of postwar planning had been considered by the Committee on Local Sec-

ESTIMATED BUDGET FOR 1942-1943 ADOPTED BY THE COUNCIL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
JUNE, 1942

Activity	Expense under committee supervision	Printing and distribution	Direct office expense	Total
Council	$ 5,500.00	....	....	$ 5,500.00
Library	9,471.00	....	....	9,471.00
Finance Committee	115.00	....	....	115.00
Nominating Committee	850.00	....	....	850.00
Awards	700.00	....	$ 354.00	1,054.00
Local Sections	28,800.00	....	7,665.00	36,465.00
Meetings and Program	6,800.00	....	8,348.00	15,148.00
Professional Divisions	3,700.00	....	5,097.00	8,797.00
Admissions	....	....	4,981.00	4,981.00
Employment Service	2,000.00	....	....	2,000.00
Membership Development	2,500.00	....	....	2,500.00
Aviation	....	....	2,750.00	2,750.00
Student Branches	12,300.00	....	4,992.00	17,292.00
Technical Committee	1,000.00	....	21,297.00	22,297.00
Transactions	....	$ 35,700.00	12,973.00	48,673.00
MECHANICAL ENGINEERING, text	....	35,500.00	10,762.00	46,262.00
Membership List	....	6,500.00	1,300.00	7,800.00
MECHANICAL ENGINEERING, advertising	....	26,100.00	29,365.00	55,465.00
A.S.M.E. Mechanical Catalog	....	22,300.00	21,924.00	44,224.00
Publications for Sale	....	27,800.00	10,324.00	38,124.00
Reserved for Boiler Code	....	3,000.00	....	3,000.00
Retirement Fund	7,700.00	....	....	7,700.00
E.C.P.D.	850.00	....	....	850.00
General committee expense	100.00	....	....	100.00
Professional services	1,300.00	....	....	1,300.00
Committee on Registration	350.00	....	....	350.00
Organization charts	125.00	....	....	125.00
Secretary's office	....	....	17,586.00	17,586.00
Accounting	....	....	18,493.00	18,493.00
General service	....	....	32,754.00	32,754.00
General office expense	....	....	16,735.00	16,735.00
	$84,161.00	$156,900.00	$227,700.00	$468,761.00

ESTIMATED INCOME FOR 1942-1943 ADOPTED BY THE COUNCIL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
JUNE, 1942

Income	Actual 1940-1941	Budget 1941-1942	Estimate 1942-1943
Initiation and Promotion Fees (to Surplus)	$ 9,837.57	$ 9,500.00	$ 9,500.00
Membership dues	230,038.86	235,000.00	234,000.00
Student dues	21,088.00	23,500.00	22,500.00
Interest and discount	10,534.05	5,000.00	6,000.00
MECHANICAL ENGINEERING, advertising	90,741.69	107,000.00	102,000.00
Mechanical Catalog, advertising	47,730.00	49,000.00	48,000.00
Publications sales	80,510.02	65,000.00	65,000.00
Miscellaneous sales	2,096.95	1,500.00	1,800.00
Contributions, *Journal of Applied Mechanics*	1,200.00	....	....
Engineering Index, Inc	495.27	....	....
Registration fees	426.00	425.00	500.00
Sale of equipment	96.00	100.00	100.00
Membership List Advertising	....	600.00	....
Total income	$484,956.84	$487,125.00	$479,900.00
To be added to surplus	19,356.06	15,919.00	11,139.00
Balance for Expense	$465,600.78	$471,206.00	$468,761.00

tions and was discussed by the Executive Committee of the Council, with the result that the president appointed a committee consisting of J. N. Landis, chairman, A. R. Cullimore, and W. D. Ennis "to draft a program to orient the Society's thinking in industrial and engineering development."

Redecoration of A.S.M.E. Rooms

The Council approved the May 20 action of the Executive Committee, on recommendation of the Finance Committee, authorizing redecoration of the rooms of the Society on the eleventh floor of the Engineering Societies Building, New York. It was pointed out that this constituted the first major expenditure for redecoration in more than a dozen years. Work of redecoration is in progress.

1942-1943 Budget Approved

The estimate of income and budget of expenditures for 1942-1943 (see page 630) was approved as jointly recommended by the Executive and Finance Committees.

Visits to Sections and Branches

Members of the Council reported on their contact with local sections and student branches in their respective areas. The President reported visits to 19 sections and 17 student branches and attendance at five meetings, including three meetings of other societies.

Amendments to By-Laws

Amendments to By-Laws B6B, Pars. 4-10, and B15, Pars. 2 and 3, were voted. Amendments to B6B were necessary because of the abandonment of the American Engineering Council, there mentioned. By-Law B15, Professional Practice, was amended by the following addition:

Par. 2 Council shall vote on the expulsion of any member only upon report of a committee of members appointed to hear the accusation and defense, recommending such expulsion.

Par. 3 (1) The Committee which shall hear and make report upon charges against accused members looking to their expulsion shall be known as the Trial Board and it shall have the same members and organization as the Nominating Committee (Art. C-7, Sec. 1). If a pending trial and a report thereon shall not have been completed during the term of members of the Nominating Committee considering the matter, the members of this Committee shall be continued as the Trial Board for such pending case until such case has been disposed of.

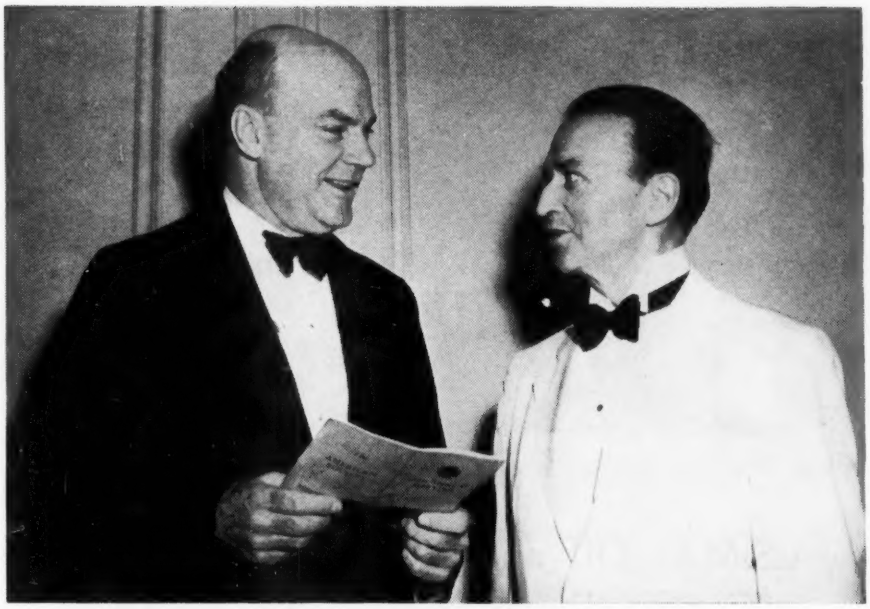
(2) Charges against a member looking to his expulsion may be brought to hearing before this Trial Board by the representation of such charges against him to the Trial Board either (*a*) by a resolution of the Council, or (*b*) by the procedure provided in Article R-15.

1943 Semi-Annual Meeting at Los Angeles

Upon recommendation of the Committees on Local Sections and Meetings and Program the Council approved selection of Los Angeles, Calif., for the 1943 Semi-Annual Meeting.

Policy on Exhibitions

A modified policy relative to exhibitions at national meetings of the Society, prepared by the Board of Technology at the request of the Executive Committee, was adopted.



SPEAKERS AT THE BANQUET, JUNE 9, AT THE A.S.M.E. SEMI-ANNUAL MEETING IN CLEVELAND, OHIO

[Addresses were delivered on "Engineers Are Thinking People," by James W. Parker (left) and on "Men and Machines," by Sir Louis Beale (right.) See pages 583-587.]

State Engineering Organizations

A progress report of the Committee on Engineering Organizations Within States was discussed at length, after which the Council took the following action:

Voted: To (1) Reiterate the policy it has frequently expressed that co-operation between the several engineering bodies in a community is highly desirable, has been frequently urged, and is again urged as an important responsibility of each of the Local Sections of the Society.

(2) Continue the committee on Engineering Organization Within States.

(3) Ask the Committee on Organization Within States to prepare a statement for dissemination to the Local Sections for discussion by them in their group conferences during the fall and for recommendation by the Group Delegates to the Council in December.

(4) Ask the Committee to prepare a further report for discussion by the Council in December, submitting it for review in advance of the meeting.

(5) Present a report in some form for discussion at the Business Meeting of the Society in December, if in the judgment of the Committee such a procedure is wise.

(6) Ask the President to urge an early convention of the Joint Conference Committee to study the organization of the national societies in their relation to the war effort.

The personnel of the Committee is as follows: W. R. Woolrich, chairman, H. O. Croft, Linn Helander, and F. H. Prouty.

Student Branches

A. C. Chick, chairman of the Committee on Relations With Colleges, described the effects on student-branch operation of the accelerated programs necessitated by the war. Upon recommendation of the committee the Council voted to approve in principle a shift of student-branch operation from a fiscal- to an "academic-year" basis and requested the committee to perfect the details for further report to the Council. Amendment to By-Law B5, Par. 9, was submitted for first reading.

The Council approved a request of the Committee on Relations With Colleges that authorization be given to accept $2.50, or more, as a token payment from "student transfers," upon notification that they are entering the armed forces. This will entitle them to junior status for which they will receive a membership card but they will not receive Society publications. At some date to be set by the Council they will become "Juniors in good standing" by payment of the remainder of the first year's dues. If the student transfer entering the armed forces does not choose to make the token payment, his status as a student transfer will be "frozen" and he will be given a 15-month period after the emergency in which to become a junior member without payment of initiation fee.

Committee on Standardization

Members of the Committee on Standardization presented policies being followed in carrying out its work through the procedure of the American Standards Association. The Committee on Standardization pointed out that there is an opportunity for the Society to set up standards which are of a more limited nature and do not need the protection of the proper procedure of the American Standards Association. On the request of the Committee on Standardization, the Council voted to authorize the Committee on Standardization to initiate standards of a limited scope and to establish a procedure for formulating these standards independent of A.S.A. procedure.

WATCHING A DEMONSTRATION OF ROAD BUILDING AT THE CATERPILLAR TRACTOR COMPANY PROVING GROUNDS DURING THE A.S.M.E. OIL AND GAS POWER MEETING AT PEORIA, JUNE 17–19

A.S.M.E. Oil and Gas Power Division Conference at Peoria, June 17–19, the Best in Its History

S.A.E. Diesel Group Co-Operates

WITH an attendance close to 500, a series of technical papers of extreme importance, and the co-operation of the Diesel group of the S.A.E., the A.S.M.E. Oil and Gas Power Division classed its fifteenth National Oil and Gas Power Conference at Peoria, Ill., June 17–19, as one of the most successful in its history. Engineering internal-combustion-engine equipment under wartime conditions was the theme around which the program of the Conference was built and in the papers and discussions or at the round-table sessions were found many of the answers to present-day problems in the Diesel field.

It was a crowded three-day program with sessions on engine design, power plants, engines, and combustion, and a round-table discussion on operation and maintenance under wartime conditions. More than thirty manufacturers displayed their products in an equipment and scientific exhibit that proved a drawing card for hundreds daily. The exhibit included a captured Mercedes-Benz aircraft angine, loaned by the Wright Aeronautical Corporation, a single-cylinder research engine with the latest devices for fuel-cetane readings, smoke records, and high-speed indicator cards, as well as other highly significant displays. The program in detail with the papers and their authors was published in MECHANICAL ENGINEERING for June, page 503.

Many of the papers presented at the A.S.M.E. sessions will be published in the Transactions of the Society together with the discussion they evoked, and this, by the way, was one of the most vital points of the meeting—that every paper was not only presented but was vigorously discussed, showing the intense interest of the audience. At some of the sessions the whole meeting had to be transferred to larger rooms and the preprints of the papers distributed disappeared as though by magic. However, it was this spirit of eager interest in papers and equipment that might be of help in solving Diesel problems that gave to the Conference a wartime aspect, an almost feverish desire to get everything possible to help on the job for victory.

"This Business of War"

At the informal banquet on June 18 Col. Willard T. Chevalier, publisher of *Business Week* and vice-president of the McGraw-Hill Publishing Co., gave a tremendously effective talk on "This Business of War." He called it the Battle of Transportation and made a stirring plea that the people of the United States wake up to the fact that this is a war to the death and that they throw their every effort into their work for victory for as he said, "this war cannot be won on the home front, but it can be lost!" L. J. Fletcher of the Caterpillar Tractor Company served as toastmaster and did an able job of introduction.

Proving-Ground Demonstration

Another outstanding feature of this Conference was the unusual opportunity afforded to observe modern large-scale Diesel-powered dirt-moving equipment in a proving-ground demonstration by the Caterpillar Tractor Company. The accompanying photograph shows the group who went on the trip to the Proving Grounds which "was restricted to those presenting Conference registration credentials." Members of the Conference are watching a road being built down an incline—and finished completely in time, clocked at 23 minutes, a feat which left everyone gasping.

S.A.E. AND A.S.M.E. OFFICERS CO-OPERATE TO MAKE MEETING A SUCCESS

(Left to right: W. L. H. Doyle, chairman, executive committee, A.S.M.E. Oil and Gas Power Division; G. C. Wilson, meetings chairman, S.A.E. Diesel-Engine Activity; C. G. A. Rosen, chairman, A.S.M.E. Central-Illinois Section and vice-chairman, Peoria District, S.A.E. Chicago Section; H. L. Knudsen, S.A.E. vice-president representing Diesel-Engine Engineering; F. L. Meyer, chairman, A.S.M.E. National Conference General Arrangements Committee; and L. N. Rowley, secretary, Executive Committee, A.S.M.E. Oil and Gas Power Division.)

HEADLINERS AT THE BANQUET

(Left to right: L. B. Neumiller, president, Caterpillar Tractor Co.; Col. Willard T. Chevalier, publisher of *Business Week* and vice-president, McGraw-Hill Publishing Co., Inc., principal speaker; and L. J. Fletcher, director of training, Caterpillar Tractor Co., toastmaster.)

Best of All — A Fish Fry

Social affairs were not lacking. One evening started with a get-acquainted buffet supper that went on into a gay-nineties party with a barbershop quartet and corn-fed entertainment where old cronies held reunions and new cronies broke the ice. The last evening of the Conference, directly after the Proving Ground exhibition, an old-style Illinois fish-fry was staged and that, according to the stories heard since the meeting, was worth a trip to Peoria—for when Jonathan Burnham, Illinois' famous fish fryer, takes luscious boneless fish, encases it in freshly ground Illinois corn, does it to a turn, serves it with special salad and trimmings—then even a Diesel engineer will devote his time to nontechnical activities. And devote it they did.

All of the activity at this Conference did not come about without good hard work—and so we present the, as-a-rule, unsung heroes who put on such a rousing good Oil and Gas Power Conference as to hang up a record for all time:

National Oil and Gas Power Conference Committees

General Arrangements

F. L. MEYER, *Chairman*
R. E. MCCLAIN, *Secretary*

C. G. A. ROSEN, C. O. SMITH, L. J. FLETCHER, R. T. MEES, L. P. WEINER, M. A. CLEMENTS, J. M. DAVIES, L. G. BRIGGS

Entertainment

L. P. WEINER, *Chairman*
C. O. SMITH, F. L. MEYER, L. J. FLETCHER

Ladies Program

MRS. F. L. MEYER, *Chairman*
MRS. W. L H. DOYLE, MRS. R. T. MEES, MRS. L. J. FLETCHER, MRS. C. G. A. ROSEN, MRS. L. P. WEINER

Proving-Ground Demonstration

J. M. DAVIES, *Chairman*

Exhibits

L. N. ROWLEY, *Chairman*
R. T. MEES, *Local Chairman*
C. E. BECK, L. WOLNIAK

Scientific Exhibits

C. W. GOOD, *Chairman*
R. E. MCCLAIN, *Local Chairman*

Transportation

W. W. BABCOCK, *Chairman*

Publicity

L. N. ROWLEY, *Chairman*
M. A. CLEMENTS, *Local Chairman*
R. T. MEES, L. G. BRIGGS, L. WOLNIAK

Registration and Meetings

R. E. MCCLAIN, *Chairman*
J. L. DEFFENBAUGH

A.G.M. Michell Awarded Watt International Medal

THE Council of The Institution of Mechanical Engineers has unanimously awarded the James Watt International Medal to A. G. M. Michell, of Melbourne, Australia, on the nomination of The Institution of Engineers, Australia, The South African Institution of Engineers, and The Engineering Institute of Canada.

The Medal was founded by the Institution in 1936 to commemorate the bicentenary of the birth of James Watt on Jan. 19, 1736. It is awarded every two years to an engineer of any nationality who is deemed worthy of the highest award that the Institution can bestow and that a mechanical engineer can receive. In making the award the Institution has secured the co-operation of the leading mechanical-engineering institutions and societies in all parts of the world.

Mr. Michell's name is best known because of his work in connection with thrust and journal bearings, but he has, in addition, made a number of extremely valuable contributions to the science of engineering in connection with centrifugal pumps and crankless engines.

Other recipients of the Watt Medal have been Sir James Aspinall, who was a famous railway engineer and administrator and an honorary member A.S.M.E., Prof. Aurel Stodola, honorary member A.S.M.E., associated with the development of the scientific design of steam turbines, also Henry Ford, honorary member A.S.M.E. and 1936 Holley Medalist.

Daniel Guggenheim Medal for 1943 Awarded to Gen. J. H. Doolittle

Dr. J. C. Hunsaker Makes Presentation

"FOR outstanding developments in the art and the science of aeronautics" the Daniel Guggenheim Medal for 1943 was presented on June 30 to General James H. Doolittle by Dr. J. C. Hunsaker (Mem. A.S.M.E.), chairman of the National Advisory Committee for Aeronautics.

Dr. Hunsaker in making the presentation emphasized the fact that General Doolittle's role in the raids on Japan was not a factor in the award. He said, "This medal is not presented for any single exploit, but for a career distinguished by many contributions to the aeronautical sciences. You were nominated for this award before you made your notable Pacific flight because you were a Doctor of Science who not only made aeronautical engineering your profession, but made flying your research laboratory.

"You obtained experimental conclusions the hard as well as the hazardous way. By daring to explore the limitations and possibilities of the airplane you have contributed to our greater knowledge of speed, control, aerobatics, and blind flying."

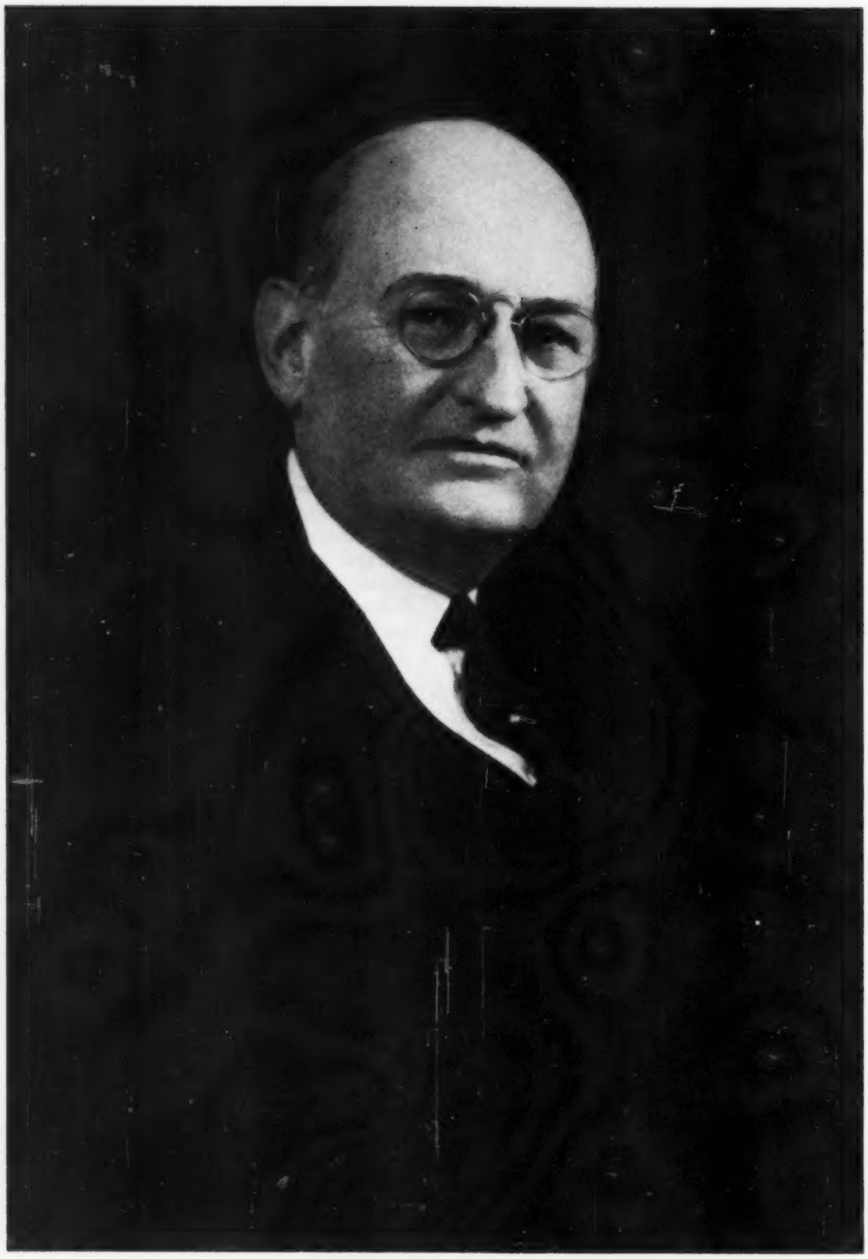
In 1938 The American Society of Mechanical Engineers awarded General Doolittle the Spirit of St. Louis Medal at its Semi-Annual Meeting in St. Louis, Mo., "for meritorious service in the advancement of aeronautics."

Bibliography Published on Circuit-Interrupting Devices

A SECOND bibliography of technical literature, "Bibliography on Circuit-Interrupting Devices, 1928–1940," has recently been published by the American Institute of Electrical Engineers. Like its predecessor, the "Bibliography of Relay Literature, 1927–1939," this special publication is sponsored by the A.I.E.E. committee on protective devices. The list of more than 850 titles includes, for the period 1928–1940, inclusive, practically all material on the subject published in the American technical and trade press and the principal articles published in other countries. The subject headings are:

Circuit Breakers (Air, Oil, Water, Rapid Reclosing, Recovery Voltages, General and Miscellaneous), Enclosed Switchgear, Air Switches, Bus Bars, and Fuses and Fuse Protection.

The "Bibliography on Circuit-Interrupting Devices, 1928–1940," a 28-page $8^1/_2 \times 11$-inch pamphlet, uniform in appearance with the "Bibliography of Relay Literature," is available from A.I.E.E. headquarters, 33 West 39th Street, New York, N. Y., at 40 cents per copy to Institute members (80 cents to nonmembers), subject to a 20 per cent discount for quantities of 10 or more mailed at one time to one address.



Harold Vinton Coes

Nominated for President

A.S.M.E. OFFICERS *Nominated for* 1942-1943

DURING the 1942 Semi-Annual Meeting of The American Society of Mechanical Engineers in Cleveland, Ohio, June 8–10, H. V. Coes, vice-president, Ford, Bacon & Davis, New York, N. Y., was nominated by the National Nominating Committee for the office of President of the Society for the year 1942–1943.

Vice-Presidents named by the Committee to serve two-year terms on the Council of the A.S.M.E. were Joseph W. Eshelman, Birmingham, Ala., Guy T. Shoemaker, Kansas City, Mo., Walter J. Wohlenberg, New Haven, Conn. Thomas E. Purcell, Pittsburgh, Pa., was nominated as vice-president to serve one year to fill out the unexpired term of the late W. H. Winterrowd.

Managers of the Society to serve on Council for three-year terms included Roscoe W. Morton, Knoxville, Tenn., Albert E. White, Ann Arbor, Mich., Alexander R. Stevenson, Jr., Schenectady, N. Y.

Members of the committee who were in attendance at Cleveland and made the nominations were: H. W. Smith, Ellwood City, Pa., chairman, representing Group V; T. E. Bell, secretary, Atlanta, Ga., Group IV; E. S. Dennison, Groton, Conn., Group I; W. McC. McKee, New York, N. Y., Group II; F. C. Stewart, State College, Pa., Group III; O. F. Campbell, East Chicago, Ind., Group VI; Julius Billeter, Salt Lake City, Utah, Group VII; and E. C. Baker, Stillwater, Okla., Group VIII.

Election of A.S.M.E. officers for 1943 will be held by letter ballot of the entire membership, closing September 22, 1942. A ballot will be mailed to every member in good standing about August 20.

Biographical sketches of the nominees follow on the succeeding pages:

Nominated for President

H. V. Coes

HAROLD VINTON COES, nominated for President of The American Society of Mechanical Engineers, is a Fellow of the Society and vice-president of Ford, Bacon & Davis, Inc., engineers of New York. He was born in Hyde Park, Mass., and studied at Northeastern Manual Training School, Philadelphia, Pa., and at Massachusetts Institute of Technology, from which he received the degree of Bachelor of Science in 1906.

From 1908 to 1911, Mr. Coes was mechanical engineer and assistant to the president of the Liquid Carbonic Co., Chicago, Ill., where he assisted in the design of, and built and operated the then largest liquid-carbonic-acid plant in the world at Cambridge, Mass. During the same period, in behalf of his company he acted as consulting engineer for the Searchlight Gas Co., acetylene-gas manufacturers. This was followed by the position of manager of the Chicago office and, later, principal industrial engineer of Lockwood, Green & Co., engineers, Boston, Mass. In 1914, he became vice-president and general manager of the Sentinel Manufacturing Co., New Haven, Conn., manufacturers of automatic gas appliances.

During 1917, he joined the staff of Gunn, Richards & Co., New York, industrial engineers, as industrial engineer, in which capacity he reorganized production in munitions plants of Canada. His work was so successful that he was invited to join the staff of Ford, Bacon & Davis, Inc., in the last year of World War I and as industrial engineer assisted in the design of munitions plants and of the Richmond, Va., plant of the Emergency Fleet Corporation for the manufacture of single-ended Scotch marine boilers for troop transports. Representing his company, he served as acting general manager, Platt Iron Works, Dayton, O., manufacturers of whippet tanks, shells, submarine pumps, compressors, etc.

During the period from 1924 to 1928, he was director, vice-president, and general manager of the Belden Manufacturing Co. of Chicago. However, preferring professional work, Mr. Coes reassociated himself with Ford, Bacon & Davis, Inc., in 1928 as manager of the industrial department and devoted his attention to problems of administration and industrial management. He served for a year representing his company as director and executive vice-president of Vulcan Iron Works, Wilkes-Barre, Pa., manufacturer of mine hoists, cement machinery and industrial locomotives. In 1937, he became a partner of the firm and, in 1941, vice-president.

Mr. Coes has been an active member of the Society since 1907, serving as Manager, 1929–1932, and as Vice-President, 1927 and 1932–1934. His committee work includes service on the Professional Divisions Committee, the Materials Handling Division as chairman, the Finance Committee as chairman, Budgeting Policy Committee, and, at present, the Special Committee on Depreciation and the Special Committee on War Production. In 1927–1928 he served as vice-chairman of the Chicago Local Section. He represented the A.S.M.E. on the board of United Engineering Trustees, Inc., serving as president and as chairman of the organization's finance committee, and is now the Society's representative on the Engineers' Defense Board.

Other national and local professional affiliations include the American Management Association of which he is chairman of the Finance Committee; Engineering Index, Inc., director; Association Consulting Management Engineers, of which he is a past-president; Society for Advancement of Management, National Manufacturers Association; Army Ordnance Association, Montclair Society of Engineers; and American Arbitration Association. For the Seventh International Management Congress, he was vice-chairman of the finance committee. He was one of three Americans selected to attend the International Budgetary Conference on budgetary procedure and control, held at Geneva, Switzerland, July, 1930.

Mr. Coes is the author of many papers on economics, management, and industrial and marketing subjects, such as "Production Control," the section on "Materials Handling" in the "Cost and Production Handbook," "Depreciation and Obsolescence," and sections in the A.M.A. "Handbook of Business Administration."

Nominated for Vice-Presidents

J. W. ESHELMAN

G. T. SHOEMAKER

T. E. PURCELL

W. J. WOHLENBERG

J. W. Eshelman

JOSEPH WILLIAM ESHELMAN, nominated for the office of Vice-President of The American Society of Mechanical Engineers, was born in Greencastle, Pa., Jan. 31, 1893. After having practiced at his profession in various parts of the country, he settled down in Birmingham, Ala., where his residence has been since 1921.

He was graduated with honors in 1911 from Pennsylvania State Normal School, Shippensburg, Pa. Following graduation, he spent a year with the U. S. Railway Mail Service. Mr. Eshelman was employed during 1912 in the engineering department of the Bell Telephone Company of Pennsylvania. The next several years were spent in Wyoming and Oregon, where he was associated with one of the large banks, in connection with its mining and lumbering interests, and also spent much time in various educational activities.

Commencing in 1917, Mr. Eshelman devoted himself exclusively to combustion-engineering

and fuel-conservation problems in the Midwest. From 1918 to 1920, he was associated with the Republic Flow Meters Company in a sales-engineering capacity at Chicago, New York, and Pittsburgh. Then, in 1920, he was appointed southern manager of the company in charge of sales in the Southeast. He served in this position until 1926 when he established his own sales-engineering business, which is known today as Eshelman and Potter, and of which he is president.

The Society received him as an associate member in 1926. He has served as chairman of the Birmingham Section, Local Sections delegate for two years, and manager of the Society from 1939 to 1942, in which capacities an active interest was shown by him in the student-branch movement and junior-engineer development and advancement. Mr. Eshelman is also a member of the Association of Iron and Steel Engineers and Birmingham Engineers Club and a registered professional engineer in Alabama.

G. T. Shoemaker

GUY T. SHOEMAKER, nominee for the office of Vice-President of The American Society of Mechanical Engineers, was born in Geneva, Ind., on Nov. 22, 1886. He attended Purdue University, receiving the B.S. degree in E.E., in 1910, and the E.E. degree in 1916. He entered industry as a student apprentice with the General Electric Company, Fort Wayne, Ind. From 1911 to 1913, he worked for the Grand Rapids Motor Truck Company, being in charge of general and special pattern designs and routing of work through the plant.

In 1913, he joined The United Light and Power Company system as a draftsman, later advancing to the positions of electrical and mechanical engineer, vice-president of the service company, vice-president and director of The United Light and Power Company, The United Light and Railways Company, and Continental Gas & Electric Corporation, and officer of several subsidiary companies.

On Aug. 1, 1938, he was appointed president of The United Light and Power Service Company, in direct charge of all engineering, construction work, and operation of subsidiary companies of the holding companies. A few of the projects handled by him include power plants at Kansas City, Mo., LaPorte, Ind., Moline, Ill., Fort Dodge, Ia., Riverside Station in Davenport, Ia., and Columbus, O., distributing systems in the Midwest, railway substations, and heating plants. Articles by him describing these projects have appeared in *Electrical World*, *Power*, and other technical publications.

In June of 1940 he resigned his affiliations with the various holding companies to devote his full time to the Kansas City Power & Light Company as vice-president, which position he holds at the present time.

Mr. Shoemaker became a member of the A.S.M.E. in 1926, and immediately took an active part in the work of the Tri-Cities Section, serving as a member of the executive committee for many years and as vice-chairman in 1933. From 1939 to 1942, he was a member of the A.S.M.E. Council in the capacity of manager.

Other professional affiliations include a fellowship in the A.I.E.E., membership on the Power Generation Committee of the Association of Edison Illuminating Companies, and former membership on the Prime Movers Committee and the Operating Committee of the Edison Electric Institute.

W. J. Wohlenberg

WALTER J. WOHLENBERG, who has been nominated for the office of Vice-President of The American Society of Mechanical Engineers, was born in Lincoln, Neb., on Feb. 17, 1888. Upon completion of a mechanical-engineering course at the University of Nebraska in 1910, he was granted the degree of B.S. in M.E. The next two years he served as an apprentice and engineer with the Westinghouse Machine Co.

In 1912, he was appointed a research fellow at the University of Illinois and received the degree of Master of Science in 1914. From 1914 to 1918, he taught at the University of Oklahoma and University of Montana. Since 1918, he has been a member of the faculty of Sheffield Scientific School, Yale University, in the mechanical-engineering department. He has held the chair of Sterling Professor of Mechanical Engineering from 1930. In 1937, Professor Wohlenberg received an honorary degree of Doctor of Engineering from the University of Nebraska. Professor Wohlenberg is also a consulting engineer in the fields of heat transfer and steam and power generation.

A member of the A.S.M.E. since 1917, and recently elected to the grade of Fellow, he has served and is serving on many of the Society's committees, such as the Power Test Codes Committee, member, 1919 to date; Technical Committee No. 3 on Fuels of the Power Test Codes Committee, chairman, 1923 to date; Special Research Committee on Absorption of Radiant Heat in Boiler Furnaces, chairman, 1928–1941; Committee on Meetings and Program, member, 1937–1941; and Executive Committee of the Fuels Division, member, 1928–1931. On the National Research Council, he was member-at-large, Division of Industrial and Engineering Research, 1931–1932, and member of the Committee on Co-ordination of Industrial and University Research, 1932–1933.

Professor Wohlenberg also holds membership in the American Chemical Society and the Society for the Promotion of Engineering Education.

T. E. Purcell

THOMAS EDWARD PURCELL, nominated for the office of Vice-President of The American Society of Mechanical Engineers for the term of one year to fill the unexpired term of the late W. H. Winterrowd, is general superintendent of power stations for the Duquesne Light Company and also general superintendent of the Allegheny County Steam Heating Company, both in Pittsburgh, Pa.

He was born Oct. 25, 1889, in Rochester, N. Y., and attended grade and high school in East Bloomfield, N. Y., and technical school in Buffalo, N. Y. Mr. Purcell entered the test department of the General Electric Co., Schenectady, N. Y., in 1910, and assisted in the development of electric ship propulsion, particularly as adapted to the original installation, the U. S. Collier *Jupiter*. In 1912, he entered the engineering department of the New York office of the company, remaining there until early in 1917 when he entered the U. S. Army as a second lieutenant in the Coast Artillery Corps. However in 1918, he was honorably discharged from the Army by the Secretary of War in order to take up his duties as assistant turbine engineer with the General Electric Co., Erie, Pa., where the production of steam-turbine propulsion equipment was under way for the U. S. Navy. Upon the completion of this work in 1919, he returned to the New York office of the company, specializing in development of large turbogenerators. In 1923, he was engaged by Dwight P. Robinson & Co., as a design engineer. From this position he entered upon his present duties in 1925.

Mr. Purcell has been active in A.S.M.E. affairs since his election to membership in 1933, at the present time being vice-chairman of Subcommittee No. 6 of the Joint Research Committee on Boiler Feedwater Studies, a member of Committee No. 6 on Steam Turbines of the Power Test Codes Committee, of the Special Committee on Steam Turbines of the United States National Committee of the International Electrochemical Commission, the Model Smoke Law Committee, and the Meetings and Program Committee of the Fuels Division. Other technical organizations in which he holds membership are the Engineers' Society of Western Pennsylvania, the National District Heating Association of which he is a past president, the Power Generation Committee of the Association of Edison Illuminating Companies, and the Prime Movers Committee, Edison Electric Institute. He represents the electric light and power group on Committee D-5 of the A.S.T.M.

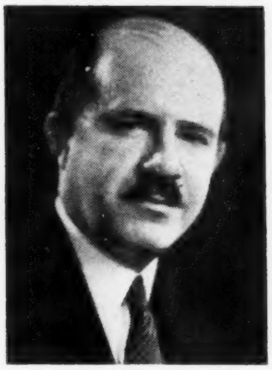
He has written many technical articles on matters pertaining to the steam and electric utility fields and produced several inventions in those branches of industry.

R. W. Morton

ROSCOE WILLIAM MORTON, selected as a candidate for the office of Manager of The American Society of Mechanical Engineers, was born in Chicago in 1900. He received the degree of B.S. in M.E. from the University of Illinois in 1923; and from the University of Colorado the degree of Master of Science in 1932 and the professional degree of M.E. in 1933.

During his junior year in college, he became

ROSCOE W. MORTON



A. R. STEVENSON, JR.

A. E. WHITE

Nominated for Managers

associated with the Leavitt Mfg. Co., Urbana, Ill., continuing with the company after graduation in work covering design, production, and sales. In 1925, he was appointed instructor in mechanical engineering at the Colorado School of Mines. Two years later, he was advanced to assistant professor of mechanical engineering and descriptive geometry. From associate professor and acting head of the department of mechanical engineering, he was promoted in 1930 to professor and head of the department. In 1938, Professor Morton accepted his present position as professor of mechanical engineering, head of the department, and director of the Central Power Station at the University of Tennessee, Knoxville, Tenn.

During summer vacation periods and teaching periods in addition to academic duties, he has been associated with many manufacturing companies as a consulting engineer on design, production, construction, and test. The recent power-plant expansion program at the University of Tennessee was carried out under his supervision.

Professor Morton joined the A.S.M.E. in 1924 as a Junior, and transferred to Associate Member in 1930 and Member in 1932. His activities on behalf of the Society have included the chairmanship of the convention committee, Semi-Annual National Meeting, Denver, Colo., 1934; honorary chairman of the Student Branch at Colorado School of Mines, 1934–1938; secretary-treasurer, 1934–1936, and chairman, 1936–1938, Colorado Local Section; delegate from Group VII to Local Sections Group Delegates Conference, Annual Meeting, New York, N. Y., 1937; honorary chairman of the Student Branch at the University of Tennessee, 1938–1941; chairman, Vegetable Oils Committee, Process Industries Division, 1939 to date; and member, Research Committee on Cottonseed Processing, 1939 to date. He has presented several papers at local and national meetings. Other professional affiliations of Professor Morton include the Society for the Promotion of Engineering Education, Tau Beta Pi, Pi Tau Sigma, Technical Society of Knoxville, and past membership in the Colorado Engineering Council.

A. E. White

ALBERT EASTON WHITE, nominee for the office of Manager of The American Society of Mechanical Engineers, was born at Plainville, Mass., on Mar. 12, 1884. He received his B.A. degree from Brown University in 1907, attended Harvard University in 1908, and obtained the honorary degree of Doctor of Science from Brown University in 1925.

From 1908 to 1911, he was associated with Jones and Laughlin Steel Company, and, since 1911, with the University of Michigan, as instructor in chemical engineering, 1911–1913, as assistant professor, 1913–1917, and as professor of metallurgical engineering, 1919 to date. Since 1920, Professor White has also been director of the department of engineering research. He is also a consulting engineer for The Detroit Edison Company, the Philadelphia Electric Company, and The American Gas and Electric Service Corporation.

During World War I, Professor White served as captain and major with the inspection division, Ordnance Department, June to Sept., 1917; head of the metallurgical branch, inspection section, gun division, Sept., 1917, to Jan., 1918; head of the metallurgical branch, inspection division, Jan., 1918, to Feb., 1919; and head of the metallurgical branch, technical staff, Feb. to Mar., 1919. He has held a commission as a Lieutenant Colonel in the Ordnance Reserve Corps until recently.

He is a member of A.S.T.M. (past-president), A.S.M. (past-president), American Chemical Society, and A.I.M.E., and has served as a member of The Engineering Foundation and the National Research Council. He has recently been appointed a member of the Metallurgical Advisory Committee of the National Academy of Sciences and the National Research Council. More than 70 articles and papers written by him have appeared in technical publications.

His activities in the A.S.M.E., of which he has been a member since 1923, include the following: Main Research Committee, member, 1924–1929, and chairman, 1929; Special Research Committee on Condenser Tubes, chairman, 1925 to date; and Nominating Committee, chairman, 1931.

A. R. Stevenson, Jr.

ALEXANDER RUSSELL STEVENSON, JR., who has been nominated for the office of Manager of The American Society of Mechanical Engineers, was born in Schenectady, N. Y., May 28, 1893. He studied at Princeton University, receiving the degree of Civil Engineer in 1914, and at Union College, obtaining his M.S. degree in 1915 and his Ph.D. degree in 1917. While in school, he worked during the summers for the American Locomotive Co., Pennsylvania Railroad, and General Electric Co. Soon after he entered the research laboratory of the General Electric Co. in June, 1917, Dr. Stevenson received a commission in the Army and was ordered to Langley Field as officer in charge of testing. Soon thereafter, he went overseas to France where he was in charge of the radio and electrical section of the Air Service, A.E.F.

Upon his return from France in 1919, he entered the power and mining-engineering department of the General Electric Co., specializing in the application of synchronous machinery to reciprocating apparatus. Not long after he was transferred to the staff of the vice-president in charge of engineering in 1923, Dr. Stevenson made the preliminary studies which led to the entrance of his company into the household-refrigerator manufacturing business. He assisted Dr. R. E Doherty in the establishment of an advanced course in engineering at the General Electric Co., helped create the company's air-conditioning department, and co-operated in the design of the kitchen waste-disposal unit. Now as staff assistant to the vice-president, he covers mechanical engineering, development of new products, and engineering education.

Dr. Stevenson has been a member of the Society since 1927 and is now serving as a member of the executive committee, Schenectady Local Section, member of the Publications Committee, chairman of the Committee on Education and Training for the Industries, and representative of the A.S.M.E. on the E.C.P.D. He is a past-president of the American Society of Refrigerating Engineers, fellow of the A.I.E.E., and president of the board of trustees, Brown School, Schenectady, N. Y.

NBC to Broadcast Program on "The Engineer at War"

Nine Remain in Series of Eleven

STARTING Thursday, July 16, the National Broadcasting Company broadcast from 6:30 to 6:45 p.m., over its nationwide network, the first of a series of eleven radio programs dealing with the contributions of engineers to the prosecution of the war, according to an announcement by Dr. R. L. Sackett, of The American Society of Mechanical Engineers, member of a committee representing the national engineering societies.

Authoritative Information

The committee has scripts under way on blackouts, bombs, and damage to structures. The National Broadcasting Company and the Office of Civilian Defense have enthusiastically endorsed the proposal and have been generous in their help and approval of scripts so far submitted. Controversial matters are included in the broadcasts and changes will be made when requested by OCD up to the minute that a program goes on the air. In this way the latest and authoritative information will be given.

The material has been prepared by eminent men or by those selected from their staffs because of special knowledge. The scripts have then been woven into a story which presents a few of the striking features of the part played by engineers in some of the more important fields.

Dates to Remember

As we go to press nine of the series remain to be broadcast, as follows:

July 30 The Resistance of Structures. Prof. H. E. Wessman, New York University.
Walter D. Binger, Commissioner of Boro Works, Manhattan.

Aug. 6 The Navy. Ships. Admiral S. M. Robinson.

Aug. 13 Dry Docks and Ship-Repair Bases. Rear Admiral Ben Moreell.

Aug. 20 Tanks and Tools, prepared by Chrysler Corporation.

Aug. 27 Airplanes, prepared by Wright Aeronautical Corporation.

Sept. 3 Petroleum Production, prepared by Robert E. Wilson, Pres., Pan American Petroleum Company.

Sept. 10 Power—Hydro, Steam, Electric. Glen B. Warren, General Elec. Co., and others.

Sept. 17 U. S. Engineers Corps in Peace and War.

Sept. 24 Communications in Action.

Mechanical-Draft Oil Burners

THE National Bureau of Standards, U. S. Department of Commerce, Washington, D. C., has just issued a pamphlet entitled "Automatic Mechanical Draft Oil Burners Designed for Domestic Installations (second edition, Commercial Standard CS75–42)." The standard has been accepted by the trade as its standard of practice for new production beginning July 20, 1942.

New Welding Standards

Committee Report Completed on Inspection of Welding

THE American Welding Society has recently published two welding standards, entitled "Standard Methods for Mechanical Testing of Welds" and "Definitions of Welding Terms and Master Chart of Welding Processes." Both of these standards were prepared by technical committees of the A.W.S. and are revisions of earlier bulletins of the same title.

Mechanical Testing of Welds

Standard Methods for Mechanical Testing of Welds describes in detail the principal mechanical tests applied to welds, including tests for density, soundness, tensile strength, shearing strength, and ductility (bend tests). The booklet includes sketches of the specimens and descriptions of the methods of testing and evaluating the results. Some of the tests apply to the weld metal alone; others apply to butt-welded joints and fillet-welded joints. In addition there is a section on etching reagents and procedures for etching.

Welding Terms and Processes

Definitions of Welding Terms and Master Chart of Welding Processes gives the standard definitions of welding terms adopted by the American Welding Society. The terms are grouped under appropriate headings and subheadings so that closely related terms appear together and their relationships may be more readily understood. In addition the booklet includes an index in which all terms are listed alphabetically. Fifty-one illustrations assist in making the various definitions clear. The booklet also includes a chart showing the various subdivisions of the principal welding processes, namely: forge welding, resistance welding, arc welding, gas welding, thermit welding, and brazing.

Both of these standards are published in bulletin form, with a heavy paper cover, and are available at 40 cents a single copy from the American Welding Society, 33 West 39th Street, New York City.

Inspection of Welding

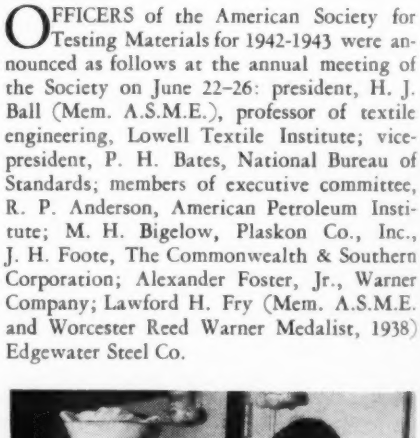
The American Welding Society has recently approved and published a committee report entitled "Recommended Practices for Inspection of Fusion Welding." This report is the result of two years' work by the Committee and represents a comprehensive treatment of the many factors involved in the inspection of welds made by the arc and oxyacetylene processes. The subjects covered include: Qualifications of welding inspectors; duties of inspectors; inspection and testing of welded structures; inspection during construction; shop and field inspections; examination of welds; radiographic inspection, hydrostatic testing and magnetic-powder inspection. A considerable part of the report deals with the welding characteristics of both ferrous and nonferrous metals. These sections describe the principal types of defects that may be encountered, indicate their usual causes, and state how they may be detected and remedied. While most of the report deals with the inspection of welds in ferrous material, there is a considerable discussion of the nonferrous metals, including copper and copper alloys, aluminum and aluminum alloys, and nickel and nickel alloys.

A.I.E.E. Elects Officers

HAROLD S. Osborne, plant engineer, operation and engineering department, American Telephone and Telegraph Company, New York, N. Y., was elected president of the American Institute of Electrical Engineers for the year beginning August 1, 1942, as announced at the annual meeting of the Institute held in Chicago, Ill., during the summer convention of the Institute. The other officers elected were: vice-presidents, K. B. McEachron, Pittsfield, Mass.; C. R. Jones, New York, N. Y.; A. G. Dewars, Minneapolis, Minn.; E. T. Mahood, Kansas City, Mo.; E. W. Schilling, Bozeman, Mont; directors, K. L. Hansen, Milwaukee, Wis.; W. B. Morton, Philadelphia, Pa. (re-elected); W. R. Smith, Newark, N. J.; national treasurer, W. I. Slichter, New York, N. Y. (re-elected).

A.S.T.M. Elects Officers

OFFICERS of the American Society for Testing Materials for 1942-1943 were announced as follows at the annual meeting of the Society on June 22–26: president, H. J. Ball (Mem. A.S.M.E.), professor of textile engineering, Lowell Textile Institute; vice-president, P. H. Bates, National Bureau of Standards; members of executive committee, R. P. Anderson, American Petroleum Institute; M. H. Bigelow, Plaskon Co., Inc., J. H. Foote, The Commonwealth & Southern Corporation; Alexander Foster, Jr., Warner Company; Lawford H. Fry (Mem. A.S.M.E. and Worcester Reed Warner Medalist, 1938) Edgewater Steel Co.



FATHER AND SON

(Lieut. Col. Marion B. Richardson (left) pins insignia on shoulder of his son, newly commissioned 2nd Lieut. Marion B. Richardson, Jr. The father served as secretary of the A.S.M.E. Railroad Division for many years. The son, an instructor in heavy weapons in the Infantry School, found his father to be one of his pupils.)

(*A.S.M.E. News continued on page 640*)

Tube-Turn Welding Fittings are built to *stand the gaff* at the turns!

FASTER INSTALLATION WITH TUBE-TURN WELDING FITTINGS

In the above assembly, Tube-Turn welding fittings are speeding up the erection schedule and permitting a compactness of piping impossible if handled any other way. Also, their uniform wall thickness makes aligning and welding quicker and easier. Note the five Tube-Turn fittings in this small piping section: (1) a 90° elbow; (2) a tee; (3) another 90° elbow; (4) a lap joint welding nipple; (5) a lap joint flange.

It's tough enough to hang on the board when a speed boat is making sharp turns along a zig-zag course, but add the perilous sport of water jousting—and the *danger at the turns* is doubled!

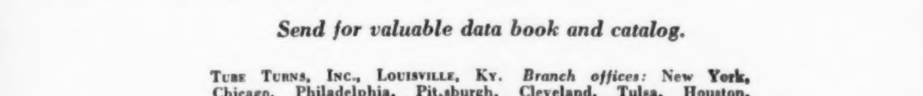
Extra punishment occurs *at the turns* in industrial piping systems, too. That's why it is safer practice to *weld piping with Tube-Turn fittings.* Tube-Turn fittings provide maximum strength, prevent leakage permanently, and practically eliminate maintenance costs.

There's a Tube-Turn fitting for *every* pipe welding need—the right type, size and weight for every job. Insist on genuine Tube-Turn welding fittings for longer life in your piping.

Send for valuable data book and catalog.

Tube Turns, Inc., Louisville, Ky. *Branch offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Tulsa, Houston, Los Angeles, Washington, D. C. *Distributors in all principal cities.*

TUBE-TURN TRADE MARK — The FIRST WELDING FITTINGS 1ST AND STILL THE BEST — *Welding Fittings*



Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient, nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Boston, Mass.	Chicago	Detroit	San Francisco
29 W. 39th St.	4 Park St.	211 West Wacker Drive	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

HEAD OF DEPARTMENT OF MECHANICAL ENGINEERING, B.S., M.S., M.E. Broad experience in engineering design, industrial design, automatic machinery, manufacturing materials and processes, dynamics of machines, and advanced stress analysis. Me-763.

MECHANICAL SUPERINTENDENT OR PLANT ENGINEER, 52. Technical graduate with long experience in supervision of chemical-plant maintenance and construction. Now in South on chemical-plant construction. Me-764.

INDUSTRIAL ENGINEER with knowledge of machine tools, conversion problems, process engineering, inspection policies, and methods organizing ability. Have proved record, finest references. Seek executive or supervisory position in line with qualifications. Me-765.

APPLICATION ENGINEER, 25, graduate B.S. M.E., working nights for B.S.E.E. Compressor and engine design, production, application, and sales experience. Married, one child. Location immaterial. Me-766.

MECHANICAL AND STRUCTURAL ENGINEER, 30 years' experience in design, construction, and maintenance of copper, rayon, and chemical plants in the States and South America. Desires responsible position. Now located in the South. Me-767.

MECHANICAL ENGINEER, Cornell Graduate, 30 years' experience in medium and heavy machinery, in various capacities of industrial engineering, design, and supervision. Services could be used to better advantage in war effort. Me-768.

POSITIONS AVAILABLE

EXECUTIVE ENGINEER OR ASSISTANT CHIEF ENGINEER, graduate mechanical, skilled on heavy machinery—Diesel engines, air compressors, etc. Must be experienced. $8000–$10,000 year. Pennsylvania. W-256.

INDUSTRIAL ENGINEER, 30–45, graduate mechanical, electrical, chemical, or metallurgical engineer of executive type. Must have at least 5 years' experience as industrial engineer with companies engaged in machining operations. Forging experience helpful. Desire knowledge of standard costs and budgeting and familiarity with Bedaux system as related to establishing standard time per piece from element data. Will be assistant to chief industrial engineer. $4200–$4800 year. Location, Pennsylvania. W-373.

INSTRUCTOR, graduate mechanical engineer, preferably with some teaching and commercial experience. Will have charge of mechanical laboratory, and expected to handle some classroom work in heat engines, thermodynamics, and possibly kinematics. Permanent. $2400 for school year, with extra for summer or defense courses. South. W-677.

TIME STUDY OR INDUSTRIAL ENGINEER with machine-shop background. $2600–$4200 year. Long Island, N. Y. W-686.

MECHANICAL OR MATERIALS ENGINEER to take charge of section dealing with standards as basis for exports. Should have experience in specification writing, testing, or other laboratory work coupled with some sales. Should be capable of meeting managing executives of various industries in development and establishment of standards. $3800 year. Permanent. Washington, D. C. W-689.

OFFICE ENGINEER, mechanical or civil, preferably with some shipyard experience, to plan and expedite work and material. Will act as assistant to general manager of shipyards. Salary, $3600–$4800 year. Location, East. W-694.

MECHANICAL ENGINEERS, for war-production work, with broad experience in fabrication of steel products. Background of technical knowledge in rolling, hot-pressing, forging, and forming rings from plate, bar, and tubing, with special emphasis on manufacturing problems. Permanent—after war company will revert to peacetime production-development work. About $4800 year. Pennsylvania. W-701.

MECHANICAL ENGINEER with good machine-tool background and knowledge of tool design to act as methods or planning engineer for plant manufacturing small high-precision parts. Must be able to designate machine operation sequence from blueprints. Permanent. Salary open. Location, Massachusetts. W-703.

ENGINEER experienced in production scheduling of electrical, piping, structural, and mechanical items to be installed in ships. $3280–$4800 year. East. W-718.

PRODUCTION SUPERVISOR. Must be competent industrial engineer and have at least 10 years' actual experience in machine-shop management. Plant is now engaged 100 per cent in war work. $6500 year. New England. W-719-B.

MACHINE-SHOP SUPERINTENDENT with good practical background in machine-shop work, preferably someone who has worked through apprentice courses and is familiar with jobbing-shop practice. Will be required to direct work of machinists and speed up production in shop. Must know operations, planers, radial drills, shapers, and other machine tools. Pennsylvania. W-734.

SUPERINTENDENT, 40–48, graduate mechanical engineer, former toolroom apprentice or equivalent, operator of production machine tools, assistant foreman, foreman, assistant superintendent, and is now, or has been, superintendent. Should know something about jigs, fixtures, tools, and dies; time-study and material control. Must be able to tell, and show, others how and what to do. Salary open. Ohio. W-736.

MECHANICAL ENGINEER with good practical background in machine-tool operation to supervise toolmakers in shop manufacturing precision gages. Applicant must have a few years' experience as tool designer or toolmaker. $5000–$8000 a year. Permanent. New York, N. Y. W-745.

CHIEF DRAFTSMAN to supervise work of 15 to 20 men in design of fluid-filter equipment. Must have experience in directing design drafting and layout of mechanical equipment. Should also know drafting-room standardization practice. Salary open. Connecticut. W-756.

MECHANICAL ENGINEER to act as supervisor of production-control department of plant doing high-precision small-parts manufacturing and assembly. Must have thorough background as he will be responsible for control program. Must be familiar with machine tools or machine-tool work. Permanent. New York, N. Y. W-763.

GRADUATE MECHANICAL ENGINEER to supervise production department. Must be fully acquainted with machine-tool operations and have about 10 years' experience on time-study and methods work in connection with this type machinery. Salary, $4000–$4800 year. Location, New York metropolitan area. W-789.

PROFESSOR, mechanical engineer, to head department of mechanical engineering. Prefer man with good all-around training in mechanical-engineering field and with some metallurgical experience. Permanent. $3000–$3600 year. West. W-813.

ASSISTANT PLANT MANAGER for company making shell casings, rear axles for motor trucks, heavy cover for axle housings, oxygen tanks, low-pressure type of stainless steel, and the windshields for the 40-mm shot. Should have experience in this type of manufacture. $6000–$7000 year. New York, N. Y. W-838.

MANAGER to take complete charge of plant manufacturing precision parts. Must know

(*A.S.M.E. News continued on page 642*)

[1] All men listed hold some form of A.S.M.E. membership.

welding nipple; (5) a lap joint flange.

metalworking machine tools and modern production methods. Permanent. New Jersey. W-858.

ENGINEER with considerable experience in the design of centrifugal pumping equipment, both from standpoints of development and hydraulic efficiency and economical standardized structural design. Should have executive ability; also general knowledge of patent work sufficient to enable him to co-ordinate his efforts with patent attorneys. Permanent. Will lead to position of chief engineer for well-qualified man. $5,000-$7000 a year. Middle West. W-890-C.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after August 25, 1942, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ALKER, HAYWARD R., New York, N. Y.
BAKER, NEAL A., N. Weymouth, Mass.
BECKWITH, CHARLES F., New York, N. Y.
BENSON, GEORGE A., New York, N. Y.
BRECKENRIDGE, ROBERT W., Ames, Iowa

(*candidates continued in next column*)

CARTER, WILLIAM F. S. (LIEUT.), Westmount, P. Q., Canada
DEARBORN, ERNEST R., Ashland, Mass.
DRUCKER, DANIEL C., Ithaca, N. Y.
DUPONT, WILLIAM B., Johnstown, Pa.
GAGNEBIN, ALBERT P., Bayonne, N. J. (Rt & T)
GIBSON, JAMES, Paisley, Scotland
HANRAHAN, FRANK J., Washington, D. C.
HERNRIED, ERWIN G., San Francisco, Calif.
HILL, CHARLES E., Waynesboro, Va.
HOLT, ARTHUR D., Columbus, Ohio
IMMEL, JOHN R., Upper Montclair, N. J.
ISHAM, CLARENCE A., Chattanooga, Tenn. (Rt & T)
JESSEN, PREBEN, New York, N. Y. (Rt & T)
KAISER, HERBERT A., Glendale, N. Y.
KORMENDY, LOUIS, Detroit, Mich., (Re)
KRESGE, WALTER C., Sayre, Pa.
LEACH, WALTER L., Fort Knox, Ky.
McCANN, WARREN E., Philadelphia, Pa., (Rt)
McCORMACK, GERALD M., San Rafael, Calif.
MITELMAN, LEON V., Chicago, Ill.
OVAITT, DAVID W., E. Orange, N. J.
PLUMMER, CLAYTON R., Knoxville, Tenn.
QUINTILIAN, BARTHOLOMEW F., Baltimore, Md.
RECHTIEN, HENRY C., JR. (LIEUT.), Tampa, Fla.
SCHRODER, CHAS. H., Phila., Pa. (Rt)
SULLWOLD, JOHN L., 2ND, San Francisco, Calif.
THOMPSON, JOHN I., Chevy Chase, Md. (Re)
VAZSONYI, ANDREW, Cambridge, Mass.
WELLS, ROBERT H., New York, N. Y. (Rt & T)
WHITTELSEY, CHARLES C., Monroe, La.
WRIGHT, CHESTER S., Chicago, Ill.
YODER, JOSEPH D., Larchmont, N. Y. (Rt)

CHANGE OF GRADING

Transfers to Member

GRODNER, ABRAHAM, Pittsburgh, Pa.
WHITE, ELLIS E., Brooklyn, N. Y.
ZIMMERMAN, HOWARD T., Hackensack, N. J.
Zsuffa, L. F. (Capt.), Governors Island, N. Y.

Transfers from Student-member to Junior......144

Necrology

THE deaths of the following members have recently been reported to headquarters:

BRENNER, WILLIAM H., June 20, 1942
CHRISTIANSON, ANDREW, March, 1942
CRAIN, L. D., March 15, 1942
DAVIS, CHARLES ETHAN, May 23, 1942
DEAN, EDMUND W., April 1, 1942
DUDLEY, WILLIAM LYLE, June 16, 1942
FLINT, BERTRAM P., May 16, 1942
GIRVIN, CHARLES J., May 10, 1942
HARRINGTON, JOHN LYLE, May 20, 1942
HORTON, ELWOOD, February 20, 1942
IDELL, PERCY C., April 13, 1942
JOHNSON, HOBART S., May 28, 1942
LARNER, CHESTER W., June 11, 1942
LEARY, GEORGE, May 7, 1942
MAHONE, FRANCIS D., May 16, 1942
MARLOW, HOMER L., May 8, 1942
ORCUTT, HARRY F. L., June 17, 1942
POUND, JOSEPH H., May 23, 1942
RAYMOND, RAYMOND P., June 20, 1942
ROSS, SIR CHARLES, June 28, 1942
SLEE, NORMAN S., June 11, 1942
STRAUB, THEODORE A., March 9, 1942
SWINFORD, JEROME K., June 6, 1942
WATERS, GEORGE H., September 5, 1941
WEBBER, HAROLD M., November 12, 1941
WEBER, RUDOLF L., April 27, 1942

Did You Know Any of These Members?

EFFORTS to secure sufficient information for memorial biographies of the following members of the A.S.M.E. have been unsuccessful. It will be greatly appreciated if members who think they may be able to help with any of these biographies will get in touch with the headquarters of the Society, 29 West 39th Street, New York, N. Y., to find out what information is desired.

FREDERICK BIRDSALL
DUANE L. BLISS, JR.
GEORGE P. BRAILO
SAMUEL S. BURGEY
PATRICK H. HOGAN
JOHN WALLACE PAUL
JOSEPH PEYSER
THOMAS TOWNE
WILLIAM S. WASHBURN

A.S.M.E. Transactions for July, 1942

THE July, 1942, issue of the Transactions of the A.S.M.E. contains:

Results of Laboratory Embrittlement Testing of Boiler Waters, F. G. Straub

Embrittlement of Boiler Steel—Experiences With the Schroeder Detector, T. E. Purcell and S. F. Whirl

Experience With Intercrystalline Cracking on Railroads, R. C. Bardwell and H. M. Laudemann

Studies on the Cracking of Boiler Plate, P. G. Bird and E. G. Johnson

Field Data From the Embrittlement Detector, E. P. Partridge, C. E. Kaufman, and R. E. Hall

Summary of Papers Composing the Symposium on Embrittlement, W. C. Schroeder and A. A. Berk

Discussion—Symposium on Embrittlement

Heat Conditions in Bearings, M. D. Hersey

Effect of Diametral Clearance on the Load Capacity of a Journal Bearing, J. T. Burwell

Heat Dissipation in Self-Contained Bearings, G. B. Karelitz

Relaxation Resistance of Nickel-Alloy Springs, B. B. Betty, E. C. MacQueen, and Carl Rolle

Symposium on Formulation of Code for Design of Helical Springs:

- What Does the Practical Spring Designer Need? J. K. Wood
- Helical-Spring Design Stresses for a Standard Code, A. M. Wahl
- Helical-Spring Tables—Scope and Arrangement, H. C. Keysor
- Future Research Work Needed in Mechanical-Spring Problems, M. F. Sayre
- Nomographic Charts—Advantages and Disadvantages, L. C. Peskin

High-Performance Fins for Heat Transfer, R. H. Norris and W. A. Spofford

Combustion of Pulverized Fuel—Mechanism and Rate of Combustion of the Low-Density Fractions of Certain Bituminous Coals, A. A. Orning

Depreciation Estimates in Appraisals of Manufacturing Equipment, P. T. Norton, Jr., and E. L. Grant

On Some of the Essentials of Control-Chart Analysis, E. G. Olds